ASTM Bulletin

NEWS—New Publications; ASTM Research Activities; Proposed Test Methods for Strength of Hydraulic-Cement Mortars; Spring Meeting and Committee Week.

PAPERS—Rheotropic Embrittlement; Oxidation Test for Inhibited Turbine Oils; High Humidity Apparatus; Gloss Evaluation; Effect of Temperature on Resilience of Elastomers; Estimation of Corrosion due to Sulfur in Oils; Index to 1952 ASTM BULLETINS.

ASTM BULLETIN

DECEMBER 1952

Number 186

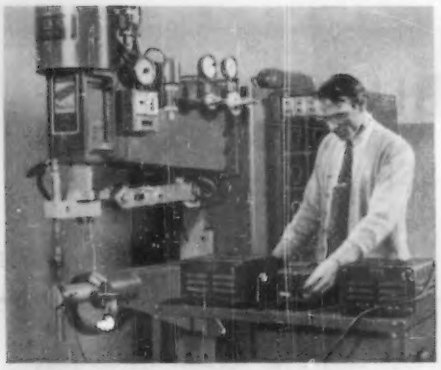
Telephone: Rittenhouse 6-5315 Cable Address: Testing, Philadelphia

IN THE SOCIETY

GENERAL NEWS NOTES

ASTM Bulletin is indexed regularly by Engineering Index, Inc.

ASTM Bulletin, December, 1952. Published eight times a year, January, February, April, May, July, September, October, and December, by the American Society for Testing Materials. Publication Office—20th and Northampton Sts., Easton, Pa. Editorial and advertising offices at the headquarters of the Society, 1916 Race St., Philadelphia 3, Pa. Subscriptions, United States and possessions, one year, $2.75; two years, $4.75; three years, $6.50; Canada, one year, $3.25; two years, $5.75, three years, $8.00. Other countries, one year, $3.75; two years, $6.75; three years, $9.50. Single Copies—50 cents. Number 186. Entered as second class matter April 8, 1940, at the post office at Easton, Pa., under the act of March 3, 1879.

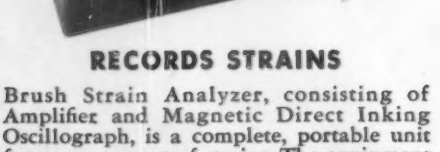


NEW WELDING ANALYZER

This new Brush Welding Analyzer helps you meet specifications without trial and error, and saves trouble-shooting time on three-phase resistance welders, single-phase resistance spot, projection, and seam welding machines. Chart records show magnitude and timing of variables, and give written proof of calibration and consistency of operation of equipment.

RECORDS STRAINS

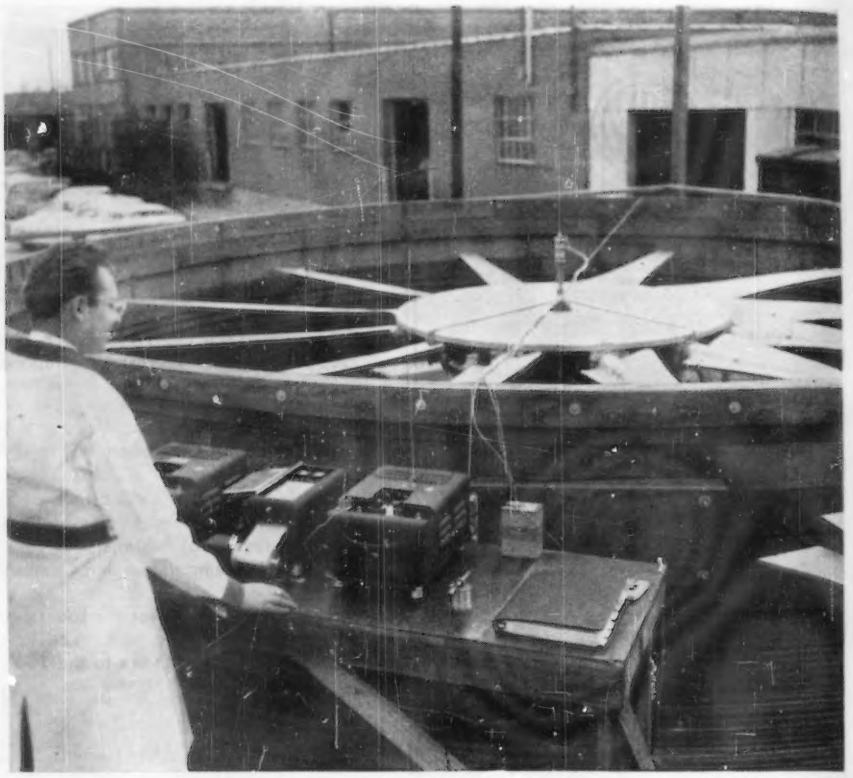
Brush Strain Analyzer, consisting of Amplifier and Magnetic Direct Inking Oscillograph, is a complete, portable unit for measurement of strains. The equipment records either static or dynamic strains up to 100 cycles per second with direction and magnitude shown on the chart.



CHARTS SURFACE PROFILE

The Brush Surface Analyzer® shows average roughness in micro-inches, and also provides a chart of surface irregularities. The chart shows a highly magnified profile of the surface, on which variations of less than 1 micro-inch are readily apparent. Eliminates guesswork in specifying and checking finishes.

For complete information write The Brush Development Company, Department J-44, 3405 Perkins Avenue, Cleveland 14, Ohio.



Streamlines measurement of operating stress with BRUSH RECORDING ANALYZER

● Here's another case where Brush Recording Analyzers simplify product development, by providing written records of operating data.

By mounting strain gages on the 20-foot cooling tower fan, and amplifying and recording the signals with a Brush Recording Analyzer, engineers of The Marley Company accurately observe operating stress on the fan, and can make quick adjustments of equipment for changing conditions.

This equipment provides a highly practical method of testing new design ideas, since measurements are recorded quickly and easily. The Marley Company, large producer of water cooling towers, also uses Brush Analyzers to check gear reducers, drive shafts, and structural members under actual service conditions.

Investigate Brush Recording Analyzers to streamline *your* testing of stress, strain, torque, vibration, pressure, and electrical characteristics. The direct-writing oscillographs provide a permanent chart record of the test—*immediately!* Brush representatives are located throughout the U.S. In Canada: A. C. Wickman, Limited, Toronto.

For catalog write The Brush Development Company, Dept. J-44, 3405 Perkins Avenue, Cleveland 14, Ohio.

PUT IT IN WRITING WITH A BRUSH RECORDING ANALYZER

THE Brush DEVELOPMENT COMPANY

BRUSH

Piezoelectric Crystals and Ceramics
Magnetic Recording Equipment
Acoustic Devices
Ultrasonics
Industrial & Research Instruments

ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

Number 186 DECEMBER, 1952

ASTM Lists Variety of New Publications

Book of Standards, Metal Cleaning Bibliography, Symposiums, and Several Compilations of Standards Recently off Press

A NUMBER of important ASTM publications are appearing this month, including one part of the big 1952 Book of ASTM Standards which is published triennially.

These publications will be of interest to individuals in all phases of industry who have need of authoritative technical information on engineering materials, standards, and specifications, and methods of test relating to them.

A brief description of the contents and background of the various books is given below.

1952 Book of ASTM Standards

So much of the work of the Society revolves about the book of ASTM Standards that the appearance of a new edition is looked upon as a major event. The members of the Society will accordingly, no doubt be interested in the present status of the work in issuing the 1952 Edition, which is now in press.

The status of each of the seven parts is as follows:

Part 1. Ferrous Metals.—The work on the makeup of this part is well advanced so that final copies should be available sometime in January, 1953. A portion of the book covering piping materials will probably be available in December.

Part 2. Non-Ferrous Metals.—The press work is now proceeding so that bound copies should be available early in December.

Part 3. Cementitious, Soils, Road and Waterproofing Materials.—There are still a number of manuscripts to be put in type for this volume so that it is doubtful if this part will appear before the end of January.

Part 4. Paint, Paint Materials, Naval Stores, Wood.—This is the first part to be completed and distribution has been made to all of those requesting them.

Part 5. Fuels, Petroleum, Aromatic Hydrocarbons.—Certain portions of this part have already been printed, for instance, the portion covering the Compilation of Standards Relating to Petroleum Products, and the press work is proceeding on the remaining portion so that copies should be available in December.

Part 6. Electrical Insulating, Plastics, Rubber.—There are still a number of manuscripts to be put in type for this volume so that it is doubtful if this part will appear before sometime in February.

Part 7. Textiles, Water, Soaps, Paper, Shipping Containers, Adhesives.—Press work is now proceeding so that copies should be available before the end of December.

New Issue of Standards in Textile Field

THE 1952 compilation of Standards of Textile Materials provides in convenient form data and information of much importance to technical personnel in the textile field.

The more than 90 ASTM standards developed by Committee D-13 on Textile Materials cover many of the widely used products of the industry. They supply methods of tests, tolerances within which the textile must come in order that it shall constitute good delivery on contract, and specification requirements—standards of quality.

In addition to related information—photomicrographs of fibers, yarn number conversion table, humidity table, committee personnel—standards in their latest approved form cover terms and definitions; testing machines; humidity and interlaboratory testing; identification; qualitative and quantitative analysis; resistance to insect pests; fibers; fabrics; yarns, threads, and cordage; hosiery; asbestos textiles, bast and leaf fiber textiles; cotton; glass textiles; wool; felt; pile fabrics; and yarn construction.

Other information contained in this new edition includes two papers presented at the 1952 ASTM meeting, "Statistical Considerations in Fiber Research," by Thomas F. Evans, and "An Application of Statistics to Quality Control in the Textile Industry," by Robert R. Jones.

Copies of this 656-page book in heavy paper cover are priced at $5; to ASTM members, $3.75. They may be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa.

1952 Piping Compilation Ready

THE ninth edition of ASTM Specifications for Steel Piping Materials provides all concerned with the production and use of steel piping materials with an up-to-date compilation of a great majority of ASTM specifications in this field.

Most of these specifications have been developed through the work of Committee A-1 on Steel, its Subcommittees IX on Pipe and Tubing and XXII on Materials for High-Temperature Service—Pipings, Castings, Forgings, etc.

Various classes of the materials covered in these 56 standards are pipe; boiler, superheater, and miscellaneous tubes; still tubes; heat-exchanger and condenser tubes; castings; forgings and welding fittings; bolting; and grain size.

This edition, which contains numerous Emergency Alternate Provisions applying to these specifications, is published in heavy paper binding and can be obtained from ASTM Headquarters for $3.75; price to members, $2.80.

D-1 Compilation Appears in Eighth Edition

THE eighth edition of the compilation of ASTM Standards on Paint, Varnish, Lacquer, and Related Products provides in convenient form the 200 specifications, tests, and definitions issued by ASTM through the work of its committee D-1.

Standards appearing in this publication cover pigments; drying oils;

paint driers and thinners; shellac; varnish and varnish materials; naval stores; lacquer and lacquer materials; traffic paint; bituminous emulsions; paint tests; putty; paint weathering tests.

A number of these standards have been approved as American Standards by the American Standards Association. Through the cooperation of the Federation of Paint and Varnish Production Clubs there are also 52 standards that have been approved as Federation Standards.

Included as information only are four proposed methods and two proposed specifications which are published in draft form for the purpose of soliciting comment.

For the first time, this compilation is appearing printed on Bible paper of the same type being used in the 1952 Book of Standards. Use of the thinner paper greatly reduces the bulk and weight of this 800-page publication making it even more convenient and useful for ready reference.

Copies, bound in heavy paper cover, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. at a price of $5.75; the price to ASTM members, $4.40.

Metal Cleaning Abstracts in New Edition

A NEW edition of *Metal Cleaning Bibliographical Abstracts 1893–1951* has just been published, bringing up through 1951 the original 1949 publication and its 1950 Supplement.

These Bibliographical Abstracts are intended to make the published data on metal cleaning readily available to the many individuals concerned with the production, finishing, and maintenance of metal products. Jay C. Harris, Assistant Director, Central Research Dept., Monsanto Chemical Co., who was responsible for collecting, arranging, and indexing the previous edition and supplement rendered the same valuable service in bringing the new edition up to date.

The material is presented in what is believed to be the most useful manner. The references, which are numbered consecutively, are arranged by year, secondarily by author. Four Indexes—Subject, Author, Specification, and Patent—have been provided to facilitate rapid reference.

Copies of the Bibliography may be obtained from Headquarters at a cost to members of $3.00; list price, $4.25.

Petroleum Compilation Now Available in 1952 Edition

THIS special compilation of ASTM specifications, tests, and definitions covering petroleum products and lubricants is one of the most widely distributed ASTM publications, providing in compact ready-reference form the ASTM standards in this field.

Sponsored by ASTM Committee D-2 on Petroleum Products and Lubricants, this compilation has been issued annually since 1927, each issue containing new material and presenting old material in its latest approved form. Methods of test for knock rating of engine fuels which are under the jurisdiction of Committee D-2 do not appear in this publication. These are issued in a special volume, the latest edition of which is now available at ASTM Headquarters. Also several standards for measuring and sampling petroleum are not included, these appearing in the ASTM Manual of Measuring and Sampling Petroleum and its Products.

The 1952 edition provides over 100 test methods, numerous specifications, lists of definitions of terms relating to petroleum and to rheological properties of matter; and recommended practice for designating significant places in specified limiting values. In addition, there are a number of appendices containing proposed tests. Recommendations on the Form of ASTM Methods of Test for Petroleum Products and Lubricants; a list of Proposed Methods prepared by Committee D-2 and published as information prior to 1952; Regulations Governing the Committee; and the latest D-2 annual report are also included.

Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Prices for heavy paper cover are $5.75; to ASTM members, $4.40. For cloth binding, add 65 cents to each of these prices.

Renewed Interest in Elastic Constants Reflected in New Symposium

THE symposium on Determination of Elastic Constants which was presented at the 1952 Annual Meeting under the sponsorship of Subcommittee 3 on Elastic Strength of Materials of Committee E-1 on Methods of Testing, was designed to review critically the various methods developed for determination of elastic constants and to focus attention on those methods which might be considered for standardization by ASTM.

The recent revival of interest in determination of elastic constants has been created in part by the availability of new materials and the increasing emphasis on lightweight structures designed to withstand dynamic loading over a wide range of temperatures. These considerations require not only a more accurate knowledge of the elastic constants already known and their extension to extreme temperatures, but also the development of techniques applicable to the plastics and composite materials now in general use in aircraft and other structures.

Four papers, each with discussion, appear in this publication, following the Introduction and Report of the Task Group by Walter Ramberg of the National Bureau of Standards, and chairman of the symposium committee and of the Task Group. The papers and their authors are:

The Influence of Temperature on the Elastic Constants of Some Commercial Steels—F. Garofalo, P. R. Malenock, and G. V. Smith

Methods of Determining the Elastic Constants of Nonmetallic Materials—E. W. Kuenzi

Dynamic Methods for Determining the Elastic Constants and Their Temperature Variation in Metals—M. E. Fine

An Evaluation of Several Static and Dynamic Methods for Determining Elastic Moduli—J. T. Richards

Copies of this 100-page symposium can be obtained from ASTM Headquarters at a price of $2; to members, $1.50.

Insulating Oil: Fourth Series

THIS symposium includes two papers presented at the meetings of Committee D-9 on Electrical Insulating Materials held in November, 1951.

The first paper by F. M. Clark, Division Engineer, Materials and Process Division, General Engineering Laboratory, General Electric Co., entitled "Evaluation of Mineral Transformer Oil During Service—Part II: Correlation of Oil Characteristics with Continued Transformer Operation" is based on an analysis of all test results then available which was made to determine the relative merits of the various laboratory tests studied.

The second paper under the joint authorship of Mr. Clark, R. G. Call, Mechanical Engineering Division, American Gas and Electric Service Corp., and T. A. McConnell, Research Engineer, Detroit Edison Co., describes the

condition of the transformers examined in a further effort to correlate the laboratory data obtained on the various oils tested with the actual condition of the transformers examined.

This is the fourth Insulating Oil symposium, the first having been published in 1946, the second in 1947, and the third in 1949.

Copies can be procured from ASTM Headquarters at $1; price to ASTM members, 75¢.

Color Difference Specification Symposium Presented by Appearance Group

A HIGHLIGHT of the 1952 spring meeting of ASTM Committee E-12 on Appearance was a Symposium on Color Difference Specification, under the joint chairmanship of Dorothy Nickerson, U. S. Department of Agriculture, and Deane B. Judd, National Bureau of Standards.

The problem of color tolerances is a practical one in many commercial and industrial fields and this symposium was designed to present some of the questions that should be considered in selecting a method of color difference specification and some of the underlying general principles of the subject.

These papers have been brought together in a Special Technical Publication now off press.

The seven papers, embodying reports from workers concerned with the practical problems of color difference and the increasing use of several instruments, appear as follows:

Specification of Color Tolerance for Carpet Wools—H. R. Davidson and E. Friede
Control of Small Color Differences in Plastics Manufacture—L. Rudick and G. W. Ingle
Colored Glass Specifications with Single Number Tolerances—N. J. Kriedl and T. G. Pett
Industrial Color Tolerance Specifications—G. L. Buc
Report of Group 4, Subcommittee 10 of D-1 on Industrial Reproducibility—F. Scofield
On the Specification of Color Differences in C. I. E. Coordinates—D. Smith
First Principles in the Expression of Color Differences—S. M. Newhall

In addition to the papers there is a general discussion, introductory materials by Miss Nickerson, and a summary by Dr. Judd.

Copies of this publication can be procured from ASTM Headquarters at $1.65; to ASTM members, $1.25.

Copies of 1951 Proceedings Needed

IN A matter of a very few weeks if not days, it will be necessary for ASTM Headquarters to advise individuals wishing to purchase the 1951 *Proceedings* that the edition of this important work is completely exhausted.

It would seem that no matter how carefully future needs are estimated, shortages are destined to occur. The problem, of course, is not without its brighter side: we like having our books reach an ever broader audience. (In the present instance, we received an unprecedented quantity order.) Nevertheless, it is our responsibility to try to satisfy all comers and in an effort to do this we are again appealing to the membership. In asking for the return of unused or rarely used copies, we would like to point out that much of the material is available in other forms, particularly preprints, and that if a member's sole interest in the book is a particular paper or report, the Society may well be able to supply his need with a smaller publication.

If your copy of the 1951 *Proceedings* is in reasonable condition for resale, we will buy it back at $5.00 upon its receipt at ASTM Headquarters. Be sure a return address is on the package to enable identification, and better still, advise that shipment is being made. If the check should be made payable to any special account or name, this should be stated clearly. Thank you.

ASTM and IP Publish Petroleum Measurement Tables Jointly

ASTM Edition—U. S. Units of Measurement

A NOTABLE example of technical collaboration, resulting from several years' work by many authorities in the field is the currently available Petroleum Measurement Tables prepared jointly by the American Society for Testing Materials and Great Britain's Institute of Petroleum.

Several years' work, numerous conferences in both countries, and calculations involving over one-quarter million IBM cards weighing two tons went into the development of these tables which are designed to serve world-wide needs. Part of the preliminary work was a conference in Brussels in 1949 in which twelve countries concerned with the metric system participated.

These tables cover the United States, British Commonwealth, and Metric Systems, the latter two being published by the Institute of Petroleum. They supersede those issued by the National Bureau of Standards *Circular C 410*. Intensive work has been contributed by many, especially Section D on Units of Measurement, Calculation and Tables of Division II of ASTM Committee D-2 on Petroleum Products and Lubricants, and Panel F, Section D of the IP Standardization Committee.

The collection of tables has been printed and bound in three different combinations for the convenience of those using them. The ASTM has published all those applicable to units of measurement used in the United States, while the IP has published those applicable to units employed in the British Commonwealth and the metric versions of these tables with the explanatory textual matter for the individual tables in English, French, and Spanish.

Copies of all the tables can be obtained from both publishing organizations. The British edition of about 520 pages, can be procured from ASTM Headquarters at $7 (£2.10.0). The Metric edition is available at $7.70. Remittances will be appreciated with the orders.

The U. S. edition of 544 pages in cloth binding can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa., at a price of $8.75; to members, $6.50.

Offers of Papers for 1953

THE Administrative Committee on Papers and Publications will meet in early February to consider the papers to be published by the Society in 1953 and to develop the program for the Annual Meeting to be held in Atlantic City, June 29 to July 3.

All those who wish to offer papers for presentation at the meeting and publication by the Society should send these offers to Headquarters *not later than January 15, 1953*. All offers should be accompanied by a summary which will make clear the intended scope of the paper and will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the Annual Meeting program.

Suitable blanks for use in transmitting this information will be sent promptly upon request to Headquarters.

Recent Actions on Standards in Steel and Copper

THE ADMINISTRATIVE COMMITTEE ON STANDARDS approved in October a new tentative specification, several revisions of standard specifications, and a number of revisions of tentative methods and specifications. These changes were submitted by Committees A-1 on Steel, B-5 on Copper and Copper Alloys, Cast and Wrought, and E-1 on Methods of Testing.

All of these new and revised specifications will appear in the forthcoming 1952 Book of Standards and in the various special compilations of selected groups of standards.

All details of the actions taken by the Administrative Committee are not given here but the accompanying table lists all items approved and the following article highlights the main features and effects of the changes made.

Steel:

A number of recommendations from Committee A-1 on Steel included one new specification and several revisions of existing standards and tentative standards.

Actions by ASTM Administrative Committee on Standards, October 21, 1952

All actions listed below were taken on the above date except as noted.

New Tentatives

Specifications for:

Cold Finished Heat Treated Alloy Steel Bars (A 364 – 52 T)

Tentative Revisions of Standards

Specifications for:

Forged or Rolled Steel Pipe Flanges, Forged Fittings and Valves and Parts for High-Temperature Service (A 105 – 46)

Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for General Service (A 181–49)

Revisions of Tentatives

Methods of:

Determination of the pH of Aqueous Solutions with the Glass Electrode (E 70 – 52 T) (Approved Oct. 23, 1952)

Compression Testing of Metallic Materials in Other Than Sheet Form (E 9 – 52 T) (Approved Oct. 23, 1952)

Specifications for:

Copper-Nickel-Zinc and Copper-Nickel Alloy Plate, Sheet, Strip, and Rolled Bar (B 122 – 52 T) (Approved Oct. 23, 1952)

General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use (A 6 – 52 T)

Seamless Low-Carbon and Carbon Molybdenum Steel Still Tubes for Refinery Service (A 161 – 52 T)

Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service (A 182 – 52 T)

Alloy-Steel Bolting Materials for High-Temperature Service (A 193 – 52 T)

Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes (A 199 – 52 T)

Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (A 200 – 52 T)

Seamless Alloy-Steel Boiler, Superheater, and Heat Exchanger Tubes (A 213 – 52 T)

Factory-Made Wrought Carbon Steel and Ferritic Alloy-Steel Welding Fittings (A 234 – 52 T)

Alloy-Steel Bars to End-Quench Hardenability Requirements (A 304 – 52 T)

Alloy-Steel Bolting Materials for Low-Temperature Service (A 320 – 52 T)

Seamless Ferritic Alloy Steel Pipe for High-Temperature Service (A 335 – 52 T)

Alloy Steel Bars for Nitriding (A 355 – 52 T)

Withdrawal of Tentatives

Methods of:

Compression Testing of Metallic Materials in Sheet Form (E 78 – 51 T) (Approved Oct. 23, 1952)

Specifications for:

Seamless Alloy-Steel Pipe for High Temperature Service (A 158 – 52 T)

Seamless Carbon - Molybdenum Alloy-Steel Pipe for High-Temperature Service (A 206 – 52 T)

Seamless Chromium-Molybdenum Alloy-Steel Pipe for Service at High Temperatures (A 280 – 52 T)

Seamless 1 per cent Chromium, 0.5 per cent Molybdenum Alloy-Steel Pipe for Service at High Temperatures (A 315 – 52 T)

In response to numerous requests for such a specification, Subcommittee XV on Bar Steel wrote a Specification for Cold-Finished Heat-Treated Alloy Steel Bars (A 364). This covers two classes of such bars, designated A and B, and provides a selection of minimum mechanical property requirements.

Standard Specifications for Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service (A 105); and Standard Specifications for Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for General Service (A 181), are revised tentatively to permit an increase of the silicon content from the present 0.30 to 0.35 per cent maximum. This recommendation became desirable because of the use of acid open hearth steel in these materials.

Revision of Tentative Specifications for General Requirements for Delivery of Rolled Steel Plates, Shapes, Bars for Structural Use and Sheet Piling (A 6) applies to the requirements for conditioning of shapes and brings these requirements essentially into agreement with those for plates with respect to permissible depth of depression. The revised section now reads, "After removal of any imperfections preparatory to welding, the thickness of the material at any location must not be reduced by more than 20 per cent of the nominal thickness of the shape."

Tentative Specifications for Seamless Alloy Steel Boiler, Superheater, and Heat Exchanger Tubes (A 213) were revised with respect to the silicon content of grade T12. This was increased to 0.45 per cent maximum on ladle analysis and 0.50 per cent on check analyis. The change was recommended because with this type of steel containing 0.15 per cent maximum carbon, a better quality grade can be assured with a somewhat higher silicon content than the 0.30 per cent maximum specified previously.

For the same reason a similar change was made in Tentative Specifications for Seamless Ferritic Alloy Steel Pipe for High-Temperature Service (A 335) in which the silicon limit of grade P12 was revised to 0.45 per cent maximum on ladle analysis and 0.50 per cent maximum on check analysis.

In response to demand from consumers for photomicrographs of practically all the grades of pipe furnished to these specifications rather than for the three grades only previously permitted, the committee has accordingly made revision to permit photomicrographs to be furnished for all the grades.

In view of the fact that these specifications, approved in 1951, have replaced older specifications and have been in industrial use for a period of one year, withdrawal of the following now obsolete specifications has been approved:

Seamless Alloy-Steel Pipe for High-Temperature Service (A 158)
Seamless Carbon-Molybdenum Alloy-Steel Pipe for High-Temperature Service (A 206)
Seamless Chromium-Molybdenum Alloy-Steel Pipe for Service at High Temperature (A 280)
Seamless 1 per cent Chromium, 0.5 per cent Molybdenum Alloy-Steel Pipe for Service at High Temperatures (A 315)

This specification was also revised as to grade symbol designations. During the development of high-temperature specifications for tubular products, forgings, and castings, slight discrepancies in grade symbol designations crept in, and this recommendation brings these designations into line with one another. The same revisions apply also to specifications for:

Seamless Low-Carbon and Carbon Molybdenum Steel Still Tubes for Refinery Service (A 161).
Specifications for Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes (A 199).
Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (A 200)
Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service (A 182)
Factory-Made Wrought Carbon Steel and Ferritic Alloy Steel Welding Fittings (A 234)
Seamless Ferritic Alloy Steel Pipe for High-Temperature Service (A 335)

The tables in Tentative Specifications for Alloy-Steel Bars to End-Quench Hardenability Requirements (A 304) have been revised on the basis that 80 per cent martensite point should be the criterion for establishing limiting sizes of the various steels.

During the development of Tentative Specifications for Alloy Steel Bars for Nitriding (A 355), which were approved at the last annual meeting, it was found that full agreement could not be reached on the requirements for microstructure. The subcommittee felt that since there was a great need for such specifications it would be advisable to recommend their publication without a section covering microstructure. Subsequent to their appearance, agreement progressed very rapidly and Committee A-1 has now recommended revision of the specifications to include the microstructure section.

The committee also revised Tentative Specifications for Alloy-Steel Bolting Materials for High-Temperature Service (A 193) to delete grades BA, BB, and BC which are now covered in the new Tentative Specifications for Quenched-and-Tempered Alloy Steel Bolts and Studs with Suitable Nuts (A 354).

Subsequent to the development of Tentative Specifications for Alloy-Steel Bolting Materials for Low-Temperature Service (A 320), other specifications covering pipe, tubing, castings, and forgings for low-temperature service have been published in which it was not felt necessary to include impact requirements for austenitic grades of steel. The committee has accordingly recommended deletion from these specifications of impact test requirements for austenitic grades L8, L8c, and L8t.

Copper and Copper Alloys:

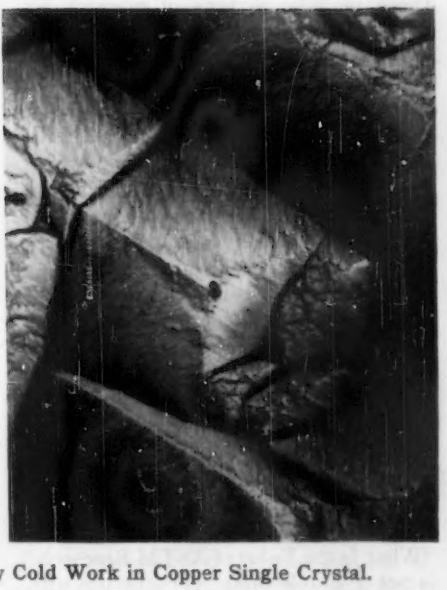
Committee B-5 on Copper and Copper Alloys, Cast and Wrought, submitted a revision of Tentative Specifications for Copper-Nickel Zinc and Copper-Nickel Alloy Plate, Sheet, Strip, and Rolled Bar (B 122) providing for deletion of maximum tin requirements in alloys 5, 6, and 7 since tin is no longer used in copper-nickel alloys.

Methods of Testing:

Subcommittee 22 on Hydrogen Ion Determinations of Committee E-1 on Methods of Testing has had changes in Tentative Methods for Determination of the pH of Aqueous Solutions with the Glass Electrode (E 70) under study for some time. Apparatus manufacturers were added to the committee to assist in the preparation of these revisions which have developed as the result of experience with this method since it was first published in 1946.

This committee also recommended revision and consolidation of Tentative Methods of Compression Testing of Metallic Materials in Other than Sheet Form (E 9) and Tentative Method of Compression Testing of Metallic Materials in Sheet Form (E 78) When the latter method was first issued it was considered desirable to publish it as a separate tentative with the result that some sections were included that were identical with the original Compression Test Methods (E 9). The present revision combines these two methods, eliminating the duplication. The revised method retains the designation E 9, and E 78 is withdrawn.

Left—As cast, slowly cooled, polished electrolytically and etched. No mechanical polishing nor other work was applied to crystal. Shows mosaic structure.



Right—Crystal deformed 20 per cent in compression, repolished electrolytically and etched again. A fine structure became visible in mosaic blocks that appeared smooth before deformation.

Microstructural Changes Produced by Cold Work in Copper Single Crystal.

Third Prize, Electron Micrographs, Eighth ASTM Photographic Exhibit, by I. N. Zavarine, Sylvania Electric Products, and Mrs. Laurence Delisle-Pellier, American Cyanamid Co.

Shadow cast parlodion replicas, single crystal made of spectroscopically pure copper by Bridgman method × 10,000, reduced in reproduction.

Review of Major ASTM Research Activities

RESEARCH is defined in the dictionary as "continued and diligent investigation." This definition without doubt can be applied to the activities of virtually all of the ASTM committees. In the broad sense of the word research is the collection and correlation of existing data; another phase of "research" would be the development of a method of test in which three or four laboratories or committee members cooperate in obtaining results and perhaps in rerunning tests on a more precise basis as a check; the formal research programs of the Society would be exemplified by the long-time exposure tests at numerous locations and which involve tens of thousands of specimens.

Several times in the past, notably in 1940, 1943, and 1947, we have reviewed in the ASTM BULLETIN the major research activities of the technical committees. The accompanying review summarizes these early reports, lists new activities, and brings the early work up to date.

How many of the projects are "pure" or "applied" research and such related questions perhaps are primarily academic ones. We have endeavored to include many of the projects particularly those having a bearing on development of test methods or extensive revisions of methods.

The Administrative Committee on Research, in addition to sponsoring these periodic reviews of research activities has recently published a list of "Unsolved Problems." These have been published regularly in the 1952 BULLETINS and in addition are available in their entirety in a separate pamphlet obtainable without charge from ASTM Headquarters, 1916 Race St., Phila. 3, Pa. It is hoped that the publication of these problems may stimulate research in the suggested fields and in that way will be mutually beneficial, not only to the Society but to the institution, group, or individual engaged in solving such problems. These problems have recently been distributed to a selected list of universities and colleges and subsequently will be distributed to other research institutions and commercial laboratories.

Obviously the answer to the question "What Is the Value of ASTM Research" is not a simple one. Perhaps the ultimate value is the greatly increased knowledge that individuals participating in and studying the research reports have acquired.

Certainly the very widespread use of ASTM standards directly reflects the Society's sound policy of research because, as has been frequently expressed, an ASTM standard is competent because it is based on *adequate scientific research.*

Certainly one of the aims in promoting knowledge of materials is to increase the efficiency and effectiveness of these materials, as expressed by Past-President F. M. Farmer who in 1925 asked, "What is our purpose in promoting knowledge of engineering materials?" and his answer was this: "To increase the efficiency and effectiveness of the materials of engineering." He pointed out that through research the circle of knowledge is widened, while through education and publicity the contents of the circle are made available to a larger proportion of humanity and thus become more useful.

Dr. F. O. Clements, six years later in discussing research in his presidential address, said that "Standardization must always go forward without building fences to prevent developments or block future progress. Standardization must be the servant and not the master. These admonitions are axiomatic ones that might properly grace the walls of our Society Headquarters. The antidote and remedy for such a danger is 'A continual search for new knowledge' or 'Research in the field of materials.'"

Dissemination of the data resulting from the research projects is essential and therefore, very extensive publications have been issued which over the years represent a most amazing encyclopedia of data. These publications in themselves bespeak the value of ASTM research work, and justify the hundreds of thousands of dollars expended by industry and government in sponsoring the work, the tremendously large number of man hours expended, and the work of the ASTM Staff.

A study of the accompanying material will convey some conception of the importance of the work. Metals groups are covered in this BULLETIN; the balance will appear in the next two issues.

COMMITTEE A-3 ON CAST IRON

Use of Gray Iron at Elevated Temperatures.—This work, organized in 1943 in cooperation with the American Foundrymen's Assn. and supported by the War Metallurgy Committee, resulted in 1944 in the issuance of the Specifications for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 F (A 278). The subcommittee was reactivated to study uses of nonpressure-containing parts, and this study resulted in a specification for nonpressure-containing parts for elevated temperature use (A 319). Additional information on creep strength was considered desirable to facilitate wider adoption of A 278, and cooperative arrangements have been made with the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals whereby a part of the funds currently being solicited by the Joint Committee will be allocated to further study of the effect of temperature on cast iron.

Microstructure of Cast Iron.—Collaboration with the American Foundrymen's Assn. resulted in a detailed report and bibliography on aspects of graphite in cast iron and the subsequent issue (1941) of a Recommended Practice for Evaluating the Microstructure of Graphite in Gray Iron (A 247). Since the 1947 revision of this recommended practice, there has been little activity within the committee along these lines.

Testing Cast Iron with SR-4 Strain Gage.—A symposium issued as *STP No. 97* promises to become an important source of information in this method of testing throughout the cast iron industry and the engineering profession in general.

COMMITTEE A-5 ON CORROSION OF IRON AND STEEL

Total Immersion Tests.—Subcommittee V on Total Immersion Tests ceased to exist actively several years ago, but circumstances prevented the preparation of a final report until 1950. This report references the series of copper and non-copper steels exposed to mine water, city water, and river and sea water immersion tests initiated in 1926 and 1927 at Portsmouth, N. H., and Key West, Fla.

Weight Uniformity and Thickness of Galvanized Coatings.—Previous extensive studies involving tests for determining weight and uniformity of zinc coatings on hardware and other shapes resulted in various tentative methods of test including Preece Test (A 239), weight of coating test (A 90), and local thickness test (A 219). Current studies include use of 1-1 hydrochloric acid instead of concentrated acid in the present hydrochloric acid–antimony chloride method of A 90. The method of test for weight and composition of coating on long-terne sheets (A 309) is under consideration to replace the concentrated sulfuric acid method by a suitable method which will remove the hazard to the analyst. Additional work includes the study of the reactions of zinc coatings in copper sulfate solutions, investigations of the Hull-Strausser type dropping test, and the measurement of nonmagnetic coatings applied to ferrous bases. A 1949 revision of A 153 (hardware coatings)

was the result of a large number of tests conducted in 1947 which brought to light several points including the effect of the surface finish of the base metal, effect of immersion time in the molten spelter, and the effect of centrifuging.

Atmospheric Corrosion Tests of Copper-Bearing and Non-Copper-Bearing Sheets.—Exposure tests of bare copper and non-copper-bearing steel sheets begun in 1915 were terminated in Pittsburgh in 1923 and at Fort Sheridan in 1928. The Annapolis tests still continue and the last results are included in the 1952 committee report.

Atmospheric Corrosion Tests of Uncoated and Galvanized Corrugated Sheets.—Studies were begun in 1926 at five test locations (Altoona, Pa., Pittsburgh, Pa., Sandy Hook, N. J., State College, Pa., and Key West, Fla.). The tests at Pittsburgh, Sandy Hook, and Key West have been discontinued, and the 1952 committee report gives the data from the final inspections at these locations as well as the latest data on the Altoona and State College tests.

Atmospheric Corrosion Tests on Wire and Wire Products.—Eleven test locations including industrial, marine, and rural were used to expose the unfabricated barbed wire, wire strand, farm field fence, and chain link fence specimens of 1936. More than 900 specimens were exposed at each location, and periodic removals have been made for determining coating weight losses and for making tension tests. The latest information concerning these tests was given in the 1951 committee report and subsequent data will be published in the odd-numbered years. A pertinent paper by A. P. Jahn may be found in the 1952 *Proceedings*.

Hardware Tests.—Metallic-coated hardware, structural shapes, tubular goods, etc., with eight types of commercial coatings were exposed at five locations in 1928. A complete report was made in the 1944 *Proceedings* where it is noted that the tests at Altoona and Pittsburgh were lost in 1942 and 1939, respectively. Progress reports have appeared periodically in the *Proceedings* in the even-numbered years. The Sandy Hook site was discontinued in 1952, leaving specimens only at State College and Key West. A new series of tests is currently being planned.

Committee A-6 on Magnetic Properties

Magnetic Properties—Direct Current Tests.—Early work of this committee including round-robin tests, formed the basis for Methods of Testing Magnetic Materials (A 34). Since 1946, investigations have been under way which include a method for testing feebly magnetic material and the use of 25-cm Epstein specimens for d-c permeability tests. The first of these resulted in a test method (A 342) and work is still continuing on the latter.

Magnetic Properties—Alternating Current Tests.—The results of early tests for alternating current methods were incorporated in Method A 34 but were subsequently placed in an individual standard (A 343). The problem of developing a method using the 25-cm Epstein frame for measuring core loss at elevated frequencies has been actively pursued. Prior investigation has gone to 2000 cycles, but it is hoped to carry these frequency studies to 10,000 cycles.

See the January Bulletin for a continuation of this research summary including all cementitious, ceramic, and masonry groups.

Aging of Electrical Sheets.—This research project mentioned briefly in the 1943 Summary of ASTM Research Activities was postponed due to war activities. Subsequent to the war the question was again raised, and a general discussion of the problem indicated that aging is no greater at 250 C than at 100 C; aging effects occurring at 100 C may be nullified at higher temperatures; the maximum rate of aging occurs at 130 C; 600 hr is too short a time to obtain the total effect; and aging is generally less at 15 kilogausses than at 10 kilogausses. On the basis of these observations, it was decided to defer the matter of a higher temperature aging test.

Committee A-7 on Malleable Iron Castings

Malleable Iron.—Committee A-7 officially announced its interest in research by revising its scope in 1947 to include "the stimulation of research." Preliminary efforts of the committee in research have been directed toward the impact properties at normal and subnormal temperatures and the problem of arriving at suitable test methods as applied to malleable iron and its related metals. The committee is also attempting to work out some arrangement with the National Bureau of Standards by which a white iron sample will be added to the Bureau's standard samples.

Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys

Correlation and Classification of Data.—Based on intensive work in collecting and classifying data, a valuable publication (*STP NO. 52*) was issued by the Society in 1942 on the properties of wrought "stainless steels." In the years preceding 1950, these data on wrought alloys were brought up to date, and in cooperation with the Alloy Casting Inst., similar data were compiled for high alloy chromium and chromium-nickel steel castings. This information was published in 1950 as "Data on Corrosion- and Heat-Resistant Steels and Alloys—Wrought and Cast" (*STP No. 52A*).

Methods of Corrosion Testing.—Early work resulted in the plant corrosion test (A 224), boiling nitric acid test (A 262), and total immersion test (A 279). In connection with the development of methods of corrosion testing, mention should be made of the "Symposium of Evaluation Tests for Stainless Steels" which was held in 1949 and issued as *STP No. 93*. As a result of this symposium, studies are under way to standardize further details of the acid copper sulfate test and the nitric-hydrofluoric acid test. The committee is cooperating with a special committee of the High Alloy Committee of the Welding Research Council, and arrangements have been made for the preparation and subsequent long-time corrosion testing of a large number of welded specimens of stainless steel. The results will be correlated with laboratory evaluation tests. A special subgroup within the committee has been working on a recommended practice for cleaning of stainless steel surfaces, and another subgroup has been organized to institute some special tests in the Pittsburgh area to compare directly the performance of 17 per cent chromium with 18 per cent chromium, 8 per cent nickel steels under conditions that will simulate the exposure of these steels on certain buildings.

Atmospheric Exposure Tests.—The atmospheric exposure program of stainless steels referred to in the 1943 and 1947 summaries has now been crystallized, and the procurement and preparation of specimens is currently under way. Appended to the 1946 committee report were data on the performance of corrosion-resisting steel on the deckhouses of the destroyers "Farragut" and "Alwyn." The 1949 report contained an appendix reporting the results of inspections of stainless steel architectural structures in New York, Philadelphia, and Atlantic City. Periodic inspections have been made of these buildings since 1937.

Mechanical Tests.—Appended to the 1944 report of the committee were the data from a cooperative study of the effect of rate of strain on tensile properties of stainless steels. Round-robin testing by five laboratories resulted in a recommendation of a limit of $\frac{1}{4}$ to $\frac{1}{2}$ in. per in. of gage length as the maximum permissible speed of testing between yield point and fracture. Recommendations on speed to yield point and on method of preparation of specimens were studied by a number of cooperating laboratories in a series of round-robin tests. The data resulting from these tests were reported in the May, 1949, Bulletin. Another phase of the mechanical testing of stainless steels is that currently being conducted by two cooperating laboratories to determine the effect of speed of testing on the tensile properties of type 301 steel and the study of methods of determining yield strength as applied to the austenitic grades.

Metallographic Studies.—In an attempt to clarify the discussion concerning the existence of sigma phase, Subcommittee VI on Metallography developed a test program aimed at methods of identifying sigma phase. Specimens were prepared in 1948 and distributed to cooperating laboratories in 1949 for the purpose of having Charpy impact tests made prior to the distribution of samples for metallographic examination and X-ray diffraction tests for the determination of the existence of sigma. Simultaneous work was carried on to determine whether an

Basketweave Titanium Structure

Honorable Mention, General Photomicrographs—Eighth ASTM Photographic Exhibit, by Edward C. Olden, Pitman-Dunn Laboratories.

The basket was created by using photomicrographs of commercially pure sintered titanium. Shading was effected by controlled printing. Etchant 3 per cent HF. ×100, reduced in reproduction.

etchant could be found that would identify sigma phase by metallographic means. The results of the impact tests and the metallographic work showed that sigma phase does develop in the molybdenum-bearing chromium-nickel steels and that, when substantial quantities of this phase are apparent, the steels lose toughness to a very great extent. There is some indication that various etching procedures can be employed, providing the composition of the steel and the heat treatments to which it has been subjected are known. A progress report is being prepared and will appear in a future report of the committee.

Committee B-1 on Wires for Electrical Conductors

Sampling Procedure.—After several years' study of very extended trials in the plants of a number of the producer members of B-1, a suitable sampling procedure based on statistical methods as developed by Committee E-11 on Quality Control of Materials has been incorporated in the specifications for hard-drawn copper wire (B 1).

Trolley Wire.—Since 1912, Committee B-1 has had the problem of developing a method of shape and dimensions for groove trolley wire. Suitable methods have now been developed and the specifications for bronze (B 9) and copper (B 47) trolley wire were revised in 1949 to include these recommendations.

Requirements for Lead Alloy-Coated Copper Wire for Electrical Purposes.—Emergency specifications ES-1a issued in 1942 for lead-coated and lead-alloy-coated wire for electrical purposes were developed as a result of cooperative work in the committee. Additional data for ductility of coatings were developed subsequent to the issuance of these emergency specifications, and the standard (B 189) was issued as a tentative in 1944. In connection with these specifications as well as the specifications for tinned copper wire, a special task group conducted an investigation to determine optimum concentration of sodium polysulfide solution for use in the tinning test prescribed in these specifications. Revisions as a result of this study were made in 1951.

Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys

Total Immersion Tests.—Early cooperative tests on immersion of copper in solutions of sulfuric acid, sodium chloride, and sodium hydroxide resulted in a Method of Total Immersion Corrosion Test of Non-Ferrous Metals (B 185). Since this method was issued, additional steps have been taken to investigate the reproducibility of the method. Several laboratories have agreed to make tests on copper, lead, and nickel in normal sulfuric acid; copper and lead in 5 *N* sodium hydroxide; and copper or red brass, lead, and prime western zinc in 1 *N* sodium chloride. Tests will be made with the specimens moving at 5 ft per min and also at 15 ft per min.

The A-10 method for conducting plant corrosion tests (A 224) was reviewed by Committee B-3, and changes mutually agreed upon were made making this method applicable to non-ferrous metals in general.

Alternate Immersion Tests.—A variety of test equipment used at different member laboratories was inspected and, as a result of the investigation, an alternate immersion corrosion test of non-ferrous metals (B 192) was issued in 1944. Subcommittee II on Alternate Immersion Test has planned a cooperative test program similar to the proposed program of Subcommittee I but has postponed its efforts pending the results of the total immersion tests.

Salt Spray Test.—Based on cooperative tests involving various methods of accelerated corrosion tests of non-ferrous metals, agreement was reached on a salt spray test in 1939 (B 117). In cooperation with Committee B-8 this method was reviewed and rather extensively revised in 1944. Variations in significant factors such as pH, air pressure, "makeup" water, etc., have been studied, and some of this work was reported in a paper by V. M. Darsey and W. R. Cavanaugh, "Apparatus and Factors in Salt Fog Testing," appended to the 1943 report.

The subgroup for several years has been studying a variation of the salt spray test, namely, the acetic acid-salt spray test, with special attention to its use for chromium-plated zinc-base die castings.

T. P. May and A. L. Alexander have published (1950 *Proceedings*) two papers reporting the results of tests using different salt sprays, including natural and artificial sea water, in regard to their effect on metals and metallic paint coatings.

Humidity Tests.—The question of humidity testing is one that has long plagued a number of the Society's committees including B-3 on Corrosion of Non-Ferrous Metals and Alloys, C-19 on Structural Sandwich Constructions, D-14 on Adhesives, D-19 on Industrial Water, and D-20 on Plastics. Committee B-3 realizing the active interest of the Armed Forces in equipment required to work under worldwide and stratospheric climatic conditions, organized a subcommittee on humidity tests in 1947. After several years it became apparent that this group could not feasibly develop a humidity test which would have a general application. The question of the humidity test was therefore passed on to the Advisory Committee on Corrosion and subsequently to Committee E-1 on Methods of Testing, which committee is now actively engaged in developing a general humidity test.

Atmospheric Corrosion.—A large number of specimens of 24 non-ferrous metals and alloys in the form of sheet or strip were exposed in 1931. Full details of materials and properties, test site locations, etc., were given in the 1932 *Proceedings*. Results of the first ten years of exposure were given in the 1944 committee report. This report formed the basis of a "Symposium on Atmospheric Exposure Tests on Non-Ferrous Metals," which was subsequently published by the Society as *STP No. 67*. All test specimens were removed in 1952 and after the usual physical tests are made a final report will be written for possible presentation in 1953.

Weather.—The first activities of the Subcommittee on Weather were the studies of the availability and usefulness of instruments for measuring temperature, rainfall, wind velocity, direction of velocity, and total solar radiation. To aid in calibrating the various test sites, specimens of iron and zinc were exposed with the object of comparing the corrosivity of the atmospheres at the different test sites with respect to these two metals. The number of specimens exposed at each site was sufficient for removal in groups after 1-, 2-, 4-, and 8-year periods so that the test will be completed in 1956 with data having been accumulated every year until that time. O. B. Ellis won the Sam Tour award in 1950 for his paper "Effect of Weather on the Initial Corrosion Weight of Sheet Zinc."

A third group has been organized to

prepare a summary of available information on methods of measuring atmospheric pollution.

Galvanic and Electrolytic Corrosion.—Typical two-metal couples of the same materials used in the 1931 non-ferrous metal program of this committee noted earlier were exposed at the same test sites in 1931. The final report of the galvanic tests was published in 1939. Tests on types 304 and 316 stainless steels coupled with various other metals were initiated in New York, Altoona, Pa., State College, Pa., and Kure Beach, N. C., in 1941. The five-year data resulting from these exposures were appended to the 1948 report of Committee B-3. A third series of galvanic couple tests consists of two types of magnesium alloys coupled to other alloys. This is a three-part program the details of which are included in the 1946 report of the committee. Exposure of the first part consisting of disk-type specimens was made in 1950. Spool-type specimens of part 2 of the program have been on exposure since 1951, and it is expected that the plate-type specimens for part 3 will be ready within a year.

Statistical Analysis.—The practical application of statistical analysis to corrosion studies of non-ferrous metals has received considerable attention by the committee and is being used in its newer exposure tests. Discussion of this phase of the work by P. S. Olmstead, W. E. Campbell, and H. G. Romig was included in the 1946 Symposium (*STP No. 67*) referred to above.

Committee B-4 On Electrical Heating, Resistance, and Related Alloys

Life Test for Durability of Electrical Resistance Wire.—Early work in the committee resulted in the publication in 1939 of an accelerated life test (B 76). Cooperative tests were made to check the equipment and accuracy of the procedure, and a five-year average of accelerated life tests was reported in 1948. Subsequent study included the quantitative effect of humidity on the life of wire at high temperature. Results of this research were included in a paper by A. deS. Brasunas and H. H. Uhlig, "Some Observations on the Accelerated ASTM Life Test for Electrical Heating Wires," October, 1949, Bulletin. A review of eleven years of testing on a single wire lot has pointed up the difference in seasonal results on test values thought to be largely due to humidity conditions. The design of life test equipment is receiving new and pointed consideration in light of the above.

Studies of Wrought and Cast Alloys for High Temperature Use.—This work involves the development of tests and specifications for heating and resistance alloys used at elevated temperatures. These studies have resulted in a test for linear expansion (B 95) and specifications for two chromium-nickel-iron alloys (B 190 and B 207). Current work includes the development of a test method to obtain oxidation resistance of alloys at high temperatures.

Thermostat Metals.—The general methods of testing thermostat metals (B 106) which were issued in 1940 have been supplemented by test for equivalent yield stress (B 191) and test for modulus of elasticity (B 223). Current investigations include the problem of hardness testing and an extensive field test program is nearing completion using two types of testers.

Materials for Radio Tubes and Incandescent Lamps.—The original program covered strip, wire, tubing, coated material, powdered material, and liquids. Extensive round-robin tests have resulted in a number of methods including wire testing (B 219) testing of sleeves and tubing (B 128), temper (spring-back method) (B 155), wire density (B 180), strength test for lead wire joints (B 203), surface flaws (B 204), wire diameter by weighing (B 205). Studies of magnetic permeability, in cooperation with Committee A-6, resulted in a 1947 revision of Method of Test for Permeability of Paramagnetic Materials (A 34). A section on cathodes has a continuing program involving cooperative tests designed to approve or disapprove new melds of electronic nickel. A standard diode tube has been developed as a means of testing and developing chemical methods to aid the definition of suitable material for cathode materials.

Resistor Alloys in Controlled Atmospheres.—The little understood phenomena of the deterioration of resistor alloys and related materials exposed to special atmospheres such as those used in electric furnace brazing and bright annealing processes were investigated by five leading companies which exchanged data on field experiences. The results of this investigation were embodied in a Method of Test for Effect of Controlled Atmospheres Upon Alloys in Electric Furnaces (B 183) in 1943. In the absence of sulfur, a type of deterioration generally referred to as green rot may occur in the temperature range between 1600 and 1800 F. Investigation of the mechanism of attack and effect of other atmospheric conditions such as variations in humidity is continuing.

Contact Materials.—Based on preliminary life tests with two different machines, cooperating laboratories carried out tests with different values of closing and opening force. Data from these tests resulted in a Method of Life Test of Electrical Contact Materials (B 182) which was approved as tentative in 1943. More recently arrangements have been made for a study in a number of laboratories for the following five tests.

1. Surety of making a circuit.
2. Welding characteristics and weight loss.
3. Arcing characteristics.
4. Contact resistance buildup.
5. Life and wear.

These characteristics will be determined for fine silver, tungsten, nickel, cadmium, copper, and coin silver. A paper discussing these problems was published in the 1947 *Proceedings* by E. I. Shobert on "Welding or Sticking of Electrical Contacts." These contact problems are currently being studied, and the results will undoubtedly lead to a series of test methods.

Committee B-5 on Copper and Copper Alloys, Cast and Wrought

Tests for Copper and Copper Alloys.—Based on extensive laboratory work, mercurous nitrate (B 154) and expansion (B 95) tests were issued in 1941; a hydrogen embrittlement test for copper was incorporated in a number of specifications in 1945. The committee has completed studies on the effect of speed of testing on tensile properties, and a paper summarizing these studies has been prepared by N. H. Murdza and is appended to the 1952 report of the committee.

Committee B-6 on Die-Cast Metals and Alloys

Investigation of Aluminum-, Zinc-, and Magnesium-Base Die-Casting Alloys.—In 1939, a group then functioning as Subcommittee XV of Committee B-2 exposed some 35,000 test specimens of 22 different zinc-base and aluminum-base die-casting alloys at six outdoor and four indoor exposure test locations. This work was transferred to Committee B-6 with its formation in 1930 from the former B-2 subcommittee and early data from these tests were reported in the 1932 1934, and 1935 *Proceedings*. Data include chemical analysis, physical tests, and photographs. In 1939, test bars of zinc and magnesium were exposed, and in 1943 tests were conducted on aluminum-base alloys containing 9.5 per cent silicon and 0.5 per cent magnesium and a series containing 8 per cent magnesium. Results of this latter series of tests were reported in 1948 and data on the 1939 series of zinc and magnesium series are to be found in the 1946 report.

Investigation of Tin- and Lead-Base Die-Casting Alloys.—A study of five tin- and lead-base alloys to determine tensile strength, creep, impact, and hardness was begun in 1937, and the final report of these tests was appended to the 1946 *Proceedings*.

Die-Casting Processes.—Extensive research has been conducted by Subcommittee IX of Committee B-6 on the effects of variations in pressure, temperature, plunger speed, die gating, die lubrication, etc., on die casting. This investigation and the conclusions drawn from the data obtained are discussed in a paper by W. Babington and D. H. Kleppinger, which was appended to the 1952 report of the committee. Another paper of interest along similar lines was that of E. Jacobi, "Flow Calculations for Die Casting Applied to the ASTM Committee B-6 Test Casting Die," which appeared in the May, 1950, Bulletin.

Committee B-7 on Light Metals and Alloys, Cast and Wrought

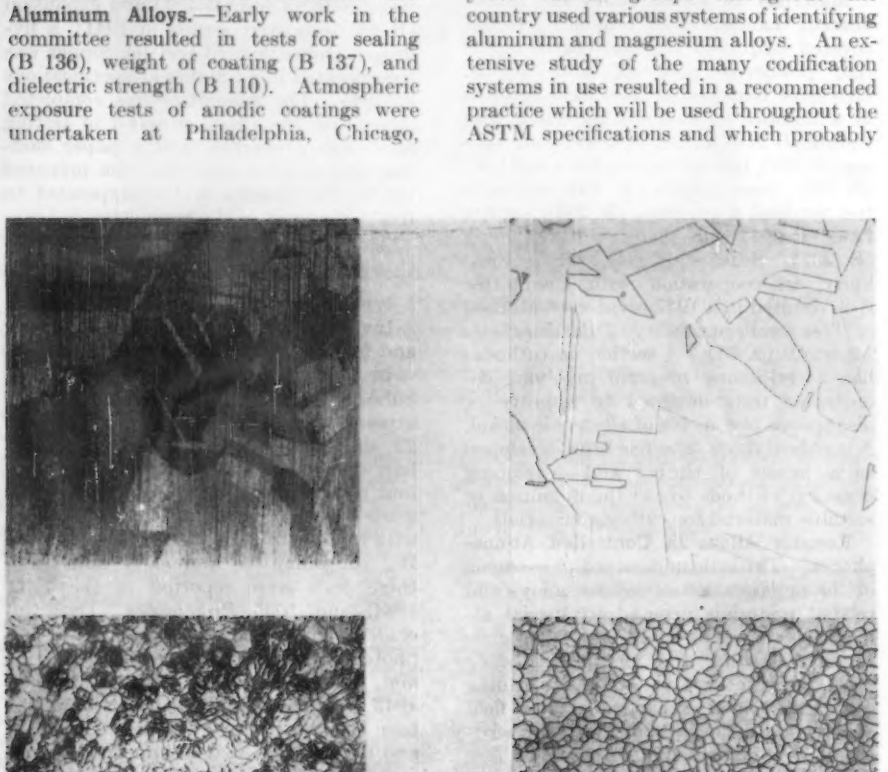
Minor Alloying Elements in Aluminum Casting Alloys.—Extensive studies to develop information on effects of impurities in commercial aluminum alloy castings and their effect on physical and corrosion-

resistant properties, castability, machinability, etc., resulted in data used in the formulation of a large number of specifications. The 1943 Dudley Medal Award was won by Walter Bonsack for a paper reporting many of these studies. Additional information was given in the October 1943, BULLETIN.

Anodic Oxidation of Aluminum and Aluminum Alloys.—Early work in the committee resulted in tests for sealing (B 136), weight of coating (B 137), and dielectric strength (B 110). Atmospheric exposure tests of anodic coatings were undertaken at Philadelphia, Chicago, New Kensington, Pa., Miami, Point Judith, R. I., and Oakland, Calif. A comprehensive investigation of the performance of thickness gages resulted in the issuance in 1949 of a Method of Measuring Thickness of Anodic Coatings on Aluminum by Means of the Filmeter (B 244).

Codification of Light Alloys.—For many years various groups throughout the country used various systems of identifying aluminum and magnesium alloys. An extensive study of the many codification systems in use resulted in a recommended practice which will be used throughout the ASTM specifications and which probably will be adopted by industry in general. This codification practice was adopted in 1952 and is identified as B 275. Work is progressing on a study of temper designations.

Corrosion Testing.—An extensive program of tests involving the exposure of more than 1500 specimens of aluminum and magnesium alloys at each of five different test sites throughout the country has been initiated, and exposure of the remaining specimens in the program will be completed by the end of this year (1952).



Removal of Surface Work and Polishing Scratches by Swab-Etch Technique (Partially and Totally).

First Prize, General Photomicrographs—Special Technique, Eighth ASTM Photographic Exhibit, by N. Raitt, Pitman-Dunn Laboratories.

Top: Soft copper, before and after, × 75. Swab etch etchant: weak potassium dichromate solution.

Center: Magnesium, before and after, × 140. Swab etch etchant: 10 per cent nitric acid in water. Final etchant: saturated ammonium chloride.

Bottom: Pure titanium, before and after, × 100. Swab etch etchant: 85 ml water, 10 ml nitric acid, 3 ml hydrofluoric acid. Reduced in reproduction.

COMMITTEE B-8 ON ELECTRODEPOSITED METALLIC COATINGS

Stress Cracking of Nickel Coatings.—A study of available information on the effect of thickness of chromium on thin nickel coatings on copper alloys with respect to stress cracking of the nickel deposits has not been sufficiently conclusive to change present specifications for chromium thickness. Consideration is being given to the use of exposure tests to obtain such information.

Atmospheric Exposure Tests of Electrodeposited Coatings on Steel.—Early results of atmospheric exposure tests of plated steel panels were included in the 1939 *Proceedings*. These investigations were extended in 1943 to include tests to determine the protective value of various thicknesses of electrodeposited lead on steel including the effect of thin electrodeposited copper undercoating. These tests were further expanded to include copper-nickel-chromium coatings on steel. The 1947 *Proceedings* contained pertinent papers on electrodeposited coatings by K. G. Soderberg, W. A. Wesley and H. A. Pray. An additional series of panels of chromium and nickel-chromium deposits on rolled nickel sheet was exposed in 1950. Reports of these studies have appeared periodically. The last report appeared in 1951. The performance test work including atmospheric exposure has been subdivided into four groups and in the future will be reported separately under copper-nickel-chromium tests, lead-coated steel tests, zinc- and cadmium-plated panels with supplementary treatments (which are currently being prepared), and a photographic rating system which is currently under study.

Thickness.—In an effort to determine reproducibility of various thickness test methods such as magnetic, stripping microscopic, and dropping tests, a number of specimens have been prepared and distributed to cooperating laboratories for thickness measurements. Data obtained will be analyzed statistically.

Porosity.—Steel panels indented by the Olsen Cup Method, nickel plated, have been distributed to four cooperating laboratories for salt (fog) testing.

Hardness.—Work has been partially completed on panels to be used for hardness measurements. These measurements will be made by means of the Knoop Indentor Method as well as other methods which have been suggested.

Luster.—The section on luster tests has investigated quantitative methods of measuring luster such as reflectivity and surface analyses. Although definite conclusions have not been reached it appears that reflectivity measurements alone are not sufficient to define luster and that surface analyzer readings must be included.

Supplementary Treatments.—The object of this research is the evaluation of corrosion protection afforded by supplementary finishes. A survey has been made of the various practices for applying chromate and phosphate treatments to zinc- and cadmium-plated steel. An exploratory exposure study of chromate-treated zinc and cadmium finishes has been completed and plans have been formulated for a more extensive program to investigate five types of chromate treatments exposed to (*a*) industrial atmosphere, (*b*) marine atmosphere, (*c*) warehouse storage and accelerated corrosion in (*a*) 100 per cent humidity, (*b*) pressure cooker, (*c*) salt spray, and (*d*) water immersion.

The effect of the hexavalent chromium content of the surface films will also be investigated. Phosphate treatments in which steel panels zinc-plated, phosphate-treated and coated with a clear alkyd varnish will be subjected to various accelerated tests as well as atmospheric exposure will be studied. Variables will be acid and cyanide zinc, and thickness of phosphate coating.

Committee B-9 on Metal Powders and Metal Powder Products

Standard Tension Test Bars.—Better interpretation and closer correlation of data involving tension test bars made from sintered metal powders depends upon a standard test bar and a die for making it. The first specially designed test bar mold gave negative results due to density variations in the specimens. Agreement has been reached on the design of two standard tension test bars and these designs are now being studied.

Standard Electrical Conductivity Test Bars.—Working in close cooperation with Committee B-4, Committee B-9 developed a test bar suitable both for tension tests and electrical resistance measurements. Cooperative tests were made using such a bar and as a result of these tests a suitable test method was developed (B 63).

Subsieve Particle Size.—Parallel tests were conducted in two laboratories on common samples using the microscopic method and the Roller air analyzer with the purpose of developing sound procedures for determining particle size of metal powders. As a result of these investigations a Method of Test for Sieve Analysis of Granular Metal Powders was developed (B 214).

Chemical Analysis.—Nine laboratories working closely with Committees E-3, B-9, and the Metal Powders Assn. developed cooperative tests on methods for determination of (*a*) oxide content of metal powders, (*b*) acid insoluble content of metal powders, and (*c*) iron content of iron powders.

These tests were supplemented by studies of methods for the determination of "hydrogen" loss of certain powders. Four tentative methods growing out of this research work have been submitted to Committee E-3.

Compressibility.—An investigation of the use of various lubricants in connection with compressibility of metal powders was initiated. Test programs in which nine laboratories cooperated indicated that this test is one which must be made under controlled conditions of die lubrication and surface finish. The investigation has now reached the proposed tentative method stage and a cooperative program is under way which will include tests of copper and iron powders and will involve the use of various dies by individual cooperators as well as the use of the same die by various participants. Discussion by F. V. Lenel of a compressibility test appeared in the May, 1949, Bulletin.

Modulus of Rupture Tests of Sintered Carbides.—The results of a study of the modulus of rupture test as a quality control method indicated that this test is so dependent upon the specimen size and preparation that it is not recommended as an acceptance test.

Hardness of Sintered Carbides.—A cooperative program on hardness testing was successful in that good agreement was obtained by the cooperating laboratories and a method for this determination is currently being drafted.

Advisory Committee on Corrosion

Corrosion Research.—Research activities in the field of corrosion and deterioration have been carried on in the Society for the most part by individual committees interested in specific materials. Development of programs, choice of test site locations, etc., still remain the prerogative of the individual committees, but in 1942 the Advisory Committee on Corrosion was organized for the express purpose of procuring, coordinating and managing the test sites. The ACC is also responsible for reviewing research programs of the various committees that may involve exposure testing. Two comprehensive reports of the ACC were published in the 1947 and the 1952 ASTM *Proceedings*, summarizing the various phases of the Society's research in the field of corrosion and deterioration.

Joint Committee on Filler Metal

A cooperative series of tests to determine the mechanical properties of aluminum and aluminum alloy gas welding rods has been initiated, and the committee expects a review of the data to form a basis for preparation of specifications for this material.

Joint Committee on Effect of Temperature on the Properties of Metals

(Joint Committee of ASTM and ASME)

General Activities.—The scope of the Joint Committee includes:

1. Accumulation of service data on various materials under high and low temperature conditions.
2. Studies leading to standardization procedure for testing metals at high temperatures.
3. Outlining and fostering research work in this field giving consideration first to the various metals and alloys intended for high temperature service in power stations, oil refineries, etc. The publications, sponsored by the committee, which have made available extensive data on the effect of temperatures on the properties of metals include: (*a*) Symposium on Effect of Temperature upon Metals (*STP No. 12*), (*b*) the volume on creep data (published in 1938 as *STP No. 37*), (*c*) Report on the Strength of Wrought Steels at Elevated Temperatures (*STP No. 100*), Symposium on Corrosion of Materials at Elevated Temperatures (*STP No. 108*), and (*d*) Symposium on the Nature, Occurrence, and Effects of Sigma Phase (*STP No. 110*).

The research projects of the joint committee can be listed under three groups as follows:

I. *Research Projects Covered by Formal Agreements:*
   1. Graphitization (part of Project 29).
   2. Effect of Variables on Manufacture (Project 18).
   3. High-Temperature Data Compilations.

II. *Research Work to be Undertaken Requiring Committee Funds:*
   1. Statistical Evaluation of Creep-Rupture Properties of Certain Sheet Materials (Aviation Panel).
   2. Effect of Stress Concentration on Fatigue of Metals at Elevated Temperatures (Gas Turbine Panel).
   3. Collection, Compilation and Publication of High-Temperature Data (Data and Publications Panel).
   4. Elevated Temperature Properties of Cast Iron (Steam Power Panel, in cooperation with Committee A-3).

III. *Research Projects Being Carried on Cooperatively Requiring No Committee Funds:*
   1. Exploratory Investigation of High-Temperature Sheet Materials for Aircraft Applications.
   2. Compilation of Experience with Metals above 1500 F.
   3. Behavior and Application of Metals at Low Temperatures.
   4. Relative Merits of 18 per cent Chromium, 8 per cent Nickel and Stabilized Grades of Austenitic Steels.
   5. Necessity for Preheating and Stress Relieving Ferritic Steels Welded with Austenitic Rods.
   6. Cracking at Welds of 12 per cent Chromium Liners in Pressure Vessels.
   7. Experience With Corrosion by Vanadium Compounds.
   8. Effect of Stress Concentration Factors on Rupture Life.
   9. Effect of Surrounding Atmosphere on Creep of Metals.

10. High-Temperature Properties of Grade B Pipe in A 106, and of Plate in A 212.

Bolting Materials.—The work on bolting materials was covered in a report by E. L. Robinson which appeared as Appendix I to the 1948 report of the committee.

Effect of Variables on the Creep Properties of Steel.—This extensive research has been summarized in a series of reports which have appeared as appendices to the report of the Joint Committee. The last such report appeared in 1951. This particular article describes the possible relationship between silicon and aluminum additions as a control of the creep resistance of fine-grain carbon steels.

Stability of Steels as Affected by Temperature.—This project studying graphitization was initiated in June 1943. It has also resulted in a series of special subcommittee reports appended to the main report of the Joint Committee. The last such special report appeared as Appendix II of the Joint Committee's report for 1951.

Elevated-Temperature Test Methods.—Data from elevated-temperature tests resulted in a recommended practice for short-time elevated-temperature tension tests of metallic materials (E 21) and a recommended practice for conducting long-time high-temperature tension tests of metallic materials (E 22). A final report on the correlation of short- and long-time elevated temperature test methods was appended to the committee's report for 1944.

Aviation Panel.—A testing program was proposed in 1949 to be known as APIA, the purpose of which was stated as "the statistical evaluation of the creep rupture properties of 5 selected alloys by a study of 10 lots of each alloy from 5 sources of supply where the grade permits. Many of the materials necessary to carry out this project have already been assembled. Results of this study will be of great importance to the aviation industry.

Other projects involving sheet materials for aircraft applications include exploratory investigations of tension, fatigue, thermal shock, rupture, and creep tests all of which are under way with several companies cooperating.

Chemical and Petroleum Panel.—Seven projects under the jurisdiction of this panel are in various stages of progress. These projects include:

1. Compilation of experience with metals above 1500 F.
2. Behavior and application of metals at low temperatures.
3. Relative merits of 18 per cent chromium, 8 per cent nickel versus the stabilized grades of austenitic steels.
4. Necessity for preheating and stress relieving ferritic steels welded with austenitic rods.
5. The cracking at the welds of 12 per cent chromium type liners in pressure vessels.
6. Differences in graphitization in the steam power field as compared to the petroleum and chemical industries.
7. Experiences with corrosion by vanadium compounds.

Gas Turbine Panel.—As soon as funds are available this panel will undertake a research project involving the effect of stress concentration on the fatigue of metals at elevated temperatures. This program will supplement another project carried on by the National Advisory Committee on Aeronautics and the combined results will be of considerable value to the engineers interested in the problems of stress concentration.

High-Temperature Steam Generation.—A special ASME Research Committee has proposed to determine:

1. The method of formation, thickness, permanence, and thermal conductivity of oxide films on steam swept surfaces.
2. The resistance of alloys to furnace gases such as may be encountered in commercial service, that is, action on the exterior tube surfaces.
3. The metallurgical stability of the contemplated materials subjected to high temperatures for long periods of time.
4. The effects of rapid tube quenching as experienced during soot blowing.

The actual research program is being undertaken at Purdue University, at Twin Branch Power Plant at Mishawaka, Ind., and at Battelle Memorial Inst.

Refractoriness Test—Super-Duty Silica Brick after Heating at 3075 Deg.

Eighth ASTM Photographic Exhibit, by W. J. Albright, Jr., United States Steel Co.

Paper on Modern Steel Bolting Presents a Summary of Specifications and Grades

AN INTERESTING paper entitled, "Modern Steel Bolting for Piping and Pressure Vessels," by C. M. Vogrin, The M. W. Kellogg Co.; Frank S. G. Williams, Taylor Forge & Pipe Works; and John S. Worth, Bethlehem Steel Co., was presented at the Petroleum Division Conference, ASME, at its September meetings in Kansas City. The introduction notes that:

> This paper was prepared for the men in industry who select bolting for piping and pressure vessel service. It is pointed toward a practical understanding of the many specifications and grades, their field of application and their current availability. To this have been added a brief summary of the thinking behind allowable design values in the Codes and a discussion of design problems and field assembly practices."

The authors present an excellent review of the numerous ASTM specifications summarizing the more pertinent data and useful tables. There is a section devoted to dimensional requirements, another on code stresses, and perhaps of particular service to those who purchase bolting would be the chapter on selection. There is also a discussion on general practices of assembly.

The authors can write authoritatively because of their experience in this field and their active participation in ASTM work. Copies can be procured at the ASME office at 29 W. 39th St., New York 18, N. Y., at 50 cents each.

Erratum

ASTM Standard on Textile Materials

Our attention has been called to page 604 of the ASTM Standards on Textile Materials where an incorrect illustration has been inserted. The correct Fig. 2, printed on gummed stock, is available on request.

Dinner Marks 50th Anniversary of Committee C-1 on Cement

THE pause that refreshes as applied to other things than a certain carbonated beverage was brought to mind to those present at the very special occasion of the 50th Anniversary Dinner of Committee C-1 on Cement. The committee members paused in the midst of their two-day session of subcommittee and committee meetings to commemorate fifty years of continuous activity as an ASTM technical committee at a dinner held at the Bellevue-Stratford Hotel in Philadelphia, Pa., on the evening of October 30. One hundred and twenty members, wives, and friends gathered for the occasion, paying tribute to the accomplishments achieved by the amiable and cooperative relationship between the many producer and nonproducer interests over these fifty years.

Ray Hess, Associate Executive Secretary of the Society, in extending the greetings of ASTM officers and staff to the group, stressed the example which the committee has set to the rest of the Society and to the engineering field down through the years in setting a pattern of how a major industry of the country has, through cooperation between the producer and the consumer, been able to insure a quality product through the use of recognized specifications and methods of tests. In particular he called attention to the work of those who were the pioneers in establishing the committee (and the technical committee pattern as a whole) as one of cooperation and group effort. He expressed the hope that the committee might think of him in view of his thirty-five years association with the committees' work as having been a longtime associate member of the committee because of his particular interest in its activities.

Frank Jackson, Bureau of Public Roads and past-chairman of Committee C-1, gave an excellent review of the progress that has been made in the development of the present standards on cement drawn from his thirty years as a consumer member of the committee. He pointed out in particular the responsibilities that the consumer must share in this cooperative, long-time endeavor and the need for insuring the consideration of the consumer viewpoint.

W. H. Klein, Dragon Cement Co., presented in an interesting fashion a summary of his experiences as a producer member of the committee for thirty-five years. He expressed the hope that the younger and newer members would gain some inspiration from the work and efforts of the teamwork of these past fifty years and proceed to new accomplishments.

Four of the six honorary members of the committee were present and each was called on for anecdotes of happenings over the years. The honorary members present were Louis Anderson, Joseph Brobston, H. S. Mattimore, and L. W. Walter.

Bob Litehiser, present chairman of the committee, functioned admirably as toastmaster, both in coordinating the dinner program and injecting his pleasing personality at the proper times to insure a smooth and pleasant sequence of events.

One of the features of the occasion was the printed program which could hardly be called just that. A booklet was presented to each one present with a cover designed in maroon and gold colors. This booklet will be a valued memento of the occasion because of the contents which, in addition to the menu and program, contained a facsimile of the minutes of the first meeting, list of charter members, list of members at the twenty-fifth anniversary in 1927, a four-page history of the committee, present organization, and last but not least, a complete set of photographs of all members of the committee. This gallery of pictures represented quite an achievement on the part of a special subcommittee under W. J. McCoy in securing 100 per cent submittal of individual photographs. W. H. Klein was general chairman of the 50th Anniversary Committee.

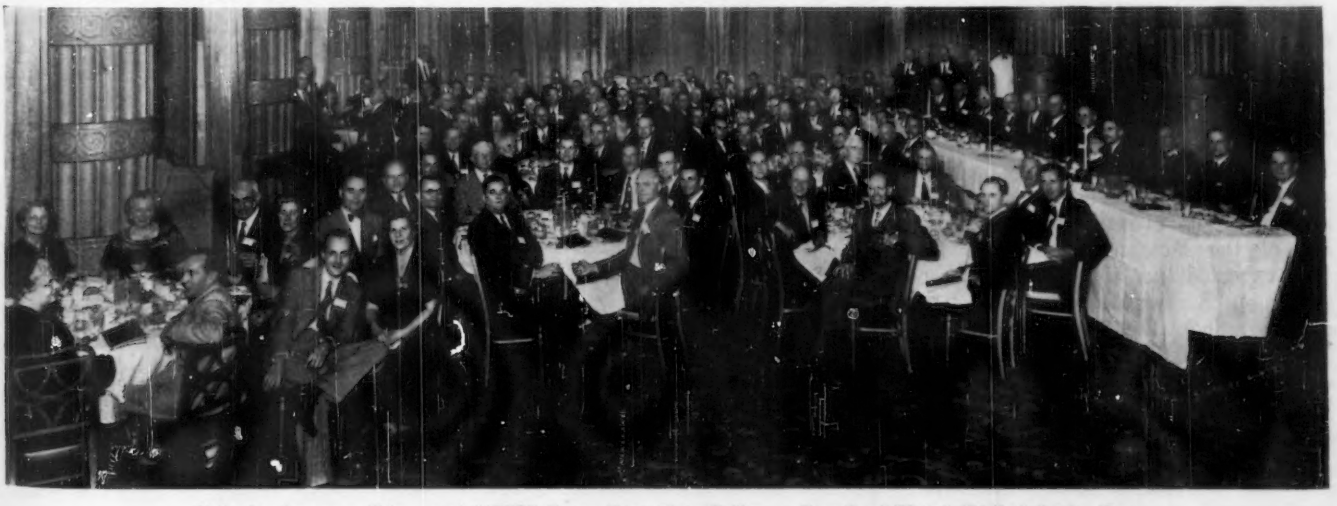
Selvig Honored by Committee D-5

ON OCTOBER 6 during the President's Night meeting of the Pittsburgh District, there was a happy interlude in the program.

W. A. Selvig, of the U. S. Bureau of Mines, was presented with two pieces of lightweight luggage specially designed for overseas travel by air.

The gift was made as a mark of sincere appreciation and friendship for Mr. Selvig by the members of ASTM Committee D-5 on Coal and Coke.

During the presentation it was recalled that Mr. Selvig has served the committee as Secretary for twenty-four years, then as Chairman for four years. The committee expressed its recognition that the sterling work and the devoted manner in which it was performed has placed both the ASTM and Committee D-5 deeply in debt to Mr. Selvig.



50th Anniversary Dinner of ASTM Committee C-1, Bellevue Stratford Hotel, Philadelphia, Pa.

ASTM Bulletin

DECEMBER 1952

NO. 186

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Detroit Scene of ASTM Spring Meeting and Committee Week, March 2-6, 1953

HIGHLIGHTS of the Spring Meeting of ASTM which will be held this year at the Statler Hotel in Detroit, Mich., Wednesday, March 4, are a Symposium on Gloss Measurement sponsored by Committee E-12 on Appearance, and a dinner for ASTM members and guests sponsored by the Detroit District.

The Spring Meeting is part of ASTM Committee Week which will extend from March 2 to 6. During this week there will be scores of meetings at Hotels Statler and Tuller of the main committees and their subcommittees who are participating. A list of the main committees that have thus far indicated that they will meet in Detroit is given below. The January BULLETIN will carry further information about committee meetings and early in January members will be advised by direct mail about hotel reservations, scheduling of committee meetings, and other details.

Symposium on Gloss Measurement

The symposium is intended to bring out the physical foundations and visual aspects of gloss with respect to various materials. The discussion will be introduced by a paper on "Gloss and Its Measurement" by Richard S. Hunter, Hunter Associates Laboratory, which paper incidentally is being printed in advance of its presentation in this issue of the BULLETIN—see page 48. It is expected that there will be other papers on "Surfaces as Seen and Photographed" and "The Physics of Surface Reflection," but it is not expected that either the papers or the discussion will be published. Everyone interested in the subject is invited to attend.

It is expected that Deane B. Judd, National Bureau of Standards, will preside over discussion of the three papers, referring questions from the floor to the authors sitting as a panel. Dr. Judd will also provide the summary of the day's work.

Committee Week

Committee Week was started many years ago to provide opportunity for a large number of committee members, particularly those with overlapping committee affiliations, to attend in a concentrated period, the meeting of the several groups in which they are interested. This has been found to effect worth-while saving in travel time and expense.

The main committees who with all or some of their subcommittees are scheduled to meet during Committee Week are listed below. Details of these meetings will be furnished to members at a later date.

B-6 on Die-Cast Metals and Alloys
B-7 on Light Metals and Alloys, Cast and Wrought
C-1 on Cement
C-3 on Chemical-Resistant Mortars
C-7 on Lime
C-8 on Refractories
C-9 on Concrete and Concrete Aggregates
C-11 on Gypsum
C-16 on Thermal Insulating Materials
D-4 on Road and Paving Materials
D-8 on Bituminous Waterproofing and Roofing Materials
D-18 on Soils for Engineering Purposes
E-5 on Fire Tests of Materials and Construction
E-9 on Fatigue
E-10 on Radioactive Isotopes
E-12 on Appearance

Detroit District Hosts

The Detroit District will act as hosts during Committee Week in their city and are planning several features for the committee members who will be in Detroit at that time. Scheduled for Spring Meeting day, Wednesday, March 4, is a dinner at the Statler.

Award of Merit Committee

WITH the acceptance of A. T. Goldbeck and H. W. Stuart, the personnel of the 1953 Award of Merit Committee is completed. These two men will serve with hold-over members, H. M. Hancock, (as Chairman) and W. A. Zinzow. T. S. Fuller will represent the Board of Directors on this committee. Page 616 of the current Year Book gives the rules governing the Award of Merit in which the ASTM technical committees have an important part.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and locations of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

DATE	GROUP	PLACE
1953		
January 8–9	B-1 on Wires for Electrical Conductors	New York, N. Y.
January 26–28	D-19 on Industrial Water	St. Louis, Mo.
February 1–6	D-2 on Petroleum Products & Lubricants	Cleveland, Ohio
February 3–5	A-1 on Steel	Birmingham, Ala.
February 20	D-6 on Paper and Paper Products	New York, N. Y.
March 2–6	ASTM SPRING MEETING AND COMMITTEE WEEK	Detroit, Mich.
March 3	E-14 on Mass Spectrometry	Pittsburgh, Pa.
March 4	E-13 on Absorption Spectroscopy	Pittsburgh, Pa.
March 16–17	D-12 on Soaps and Other Detergents	New York, N. Y.
March 18–20	D-13 on Textiles	New York, N. Y.
March 23–25	D-20 on Plastics	Pocono Manor, Pa.
March 25–27	D-9 on Electrical Insulating Materials	Pocono Manor, Pa.
April 9–10	C-19 on Structural Sandwich Construction	Dallas, Tex.
June 29–July 3	ASTM ANNUAL MEETING	Atlantic City, N. J.

Staff Trio Joins "Twenty-Five Year Service Club"

AT A DINNER held at the Society's headquarters, tribute was paid to three members of the Staff who have completed, this year, twenty-five years of service. The addition of these three brings the "Twenty-five Year Club" up to a total membership of 8, consisting, chronologically, of J. K. Rittenhouse (1934) (Treasurer Emeritus), Marie A. Ounan (1942), R. E. Hess (1945), G. A. Wilson (1949), and Dorothy E. Hand (1951). The late C. L. Warwick was also one of those who had completed 25 years service in the Staff.

Florence Artis, Paul Smith and Mary Dickson.

Paul J. Smith

Back in April, 1927, a smiling young fellow, recently out of college, swelled the existing "large" ASTM staff to a total of 10. Paul Smith was born in Philadelphia and received his Bachelor of Science degree in Civil Engineering from the University of Pennsylvania. While his experience with the Society covered a diversity of ASTM activities, he has from the beginning been connected with the editing and publishing of the ever increasing number of ASTM Standards. In addition to his position as Standards Editor, Mr. Smith, as Assistant Technical Secretary, has followed very closely the work of many of the Society's Technical Committees. His closest connections have been with Committees D-2 on Petroleum Products and Lubricants, D-1 on Paint, Varnish, Lacquer, and Related Products, D-11 on Rubber and Rubber-Like Materials, D-20 on Plastics. He succeeded R. E. Hess as secretary of Committees E-1 on Methods of Testing and E-8 on Nomenclature and Definitions.

Mary E. Dickson

Miss Mary Dickson started her affiliation with the Society in November, 1927. From that time on she has been responsible for the records that have been kept so excellently of the Society's membership and personnel of Technical Committees. A glance at the membership and committee list in the Year Book in itself would be indicative of the vastness of the task handled so capably by Miss Dickson and her department. However, in order to get a full appreciation of the extensiveness of the record that must be maintained of the Society's members and their committee affiliations, an inspection of the 20-foot visible file housing these records would be convincing. The dynamic personality and sunny smile of Miss Dickson have stood her in good stead with all her associates.

Florence Artis

In March, 1927, Miss Florence Artis entered the employ of the Society. Up until 1946 she was in J. K. Rittenhouse's department working principally with sales of publications. In 1946 when Headquarters outgrew the office space in the Atlantic Building and our members decided that the Society should own its own building, a new position of office manager developed. With the establishment of an office management department, Miss Artis became secretary to J. H. Wolfe. Miss Artis also handles sales of individual reprints of Standards, Committee Reports, and Technical papers. Many of our members who have occasion to telephone headquarters have had the pleasure of speaking with her when she so capably relieves as receptionist.

1953 Lecturers Announced

Two distinguished lectures are in prospect for the 1953 Annual Meeting when Frederick D. Rossini will present the 27th Marburg Lecture and Jerome Strauss the second H. W. Gillett Memorial Lecture.

Dr. Rossini who is the Head of the Department of Chemistry and Director of the American Petroleum Institute Research Laboratory at Carnegie Institute, will speak on the subject of physical constants and thermodynamic properties of hydrocarbons.

Mr. Strauss, Vice-President of Vanadium Corp. of America and long-time member of ASTM brings many years' experience to the preparation of the Gillett Lecture which was established to commemorate Dr. Gillett and to cover his field of special interest, the testing and evaluation of metals.

Annual Meetings in 1954 and 1955

A LOOK ahead in the activities of the Society reveals that the 1954 annual meeting will be held in the great Mid-West industrial area, at Chicago's Sherman and Morrison Hotels, the week of June 14–18.

The Board has taken cognizance of the possibility of hot weather at that time of year and has directed that every effort be made to schedule meetings and events in air-conditioned rooms at both hotels.

Tentative plans for the 1955 annual meeting indicate a return to Chalfonte-Haddon Hall in Atlantic City, during the week of June 26.

Calendar of Other Society Events

"Long" and "short" calendars will appear in alternate BULLETINS. The "short" calendar notes meetings in the few immediate weeks ahead—the "long" calendar for months ahead.

AMERICAN ASSOCIATION ADVANCEMENT OF SCIENCE—Dec. 26–31, Annual Meeting, St. Louis, Mo.

AMERICAN CHEMICAL SOCIETY—Dec. 27–28, 18th Annual Chem. Engr. Symposium, Evanston, Ill.

1953

AMERICAN CHEMICAL SOCIETY—Jan. 2–3, Div. of Industrial & Engr. Chemistry, 18th Annual Chem. Engr. Symposium, Yale University.

SOCIETY OF AUTOMOTIVE ENGINEERS—Jan. 12–16, Annual Meeting & Eng. Display, Sheraton-Cadillac Hotel, Detroit, Mich.

SOCIETY OF PLASTICS ENGINEERS, INC.—Jan. 21, 22, 23, 9th Annual Technical Conference, Hotel Statler, Boston, Mass.

AMERICAN ROAD BUILDERS' ASSN.—Feb. 8–12, 1953 National Convention, Boston, Mass.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, INC.—Feb. 16–19, Annual Meeting, Statler Hotel, Los Angeles, Calif.

Among those present at the St. Louis District Meeting at the Engineers' Club were, left to right: Messrs. Lischer, Brust, Harvey, White, Kohlberg, Magruder (District Secretary), Weber, Kester, Roberts (District Chairman), Kraft, and Buxton.

St. Louis District Hears President Maxwell on Chemical Processes

ASTM PRESIDENT Harold Lee Maxwell was warmly received by members and guests of the St. Louis District and the Engineers' Club of St. Louis whom he addressed at the District meeting, October 30, at the Engineers' Club.

Dr. Maxwell, who is Supervisor of Mechanical Engineering Consultants, E. I. du Pont de Nemours & Co., Inc., spoke on the subject, "Chemical Developments and Engineering Materials."

In this talk Dr. Maxwell discussed how, from a few grains of a new material developed in the research laboratory, processes are evolved for the manufacture of the new material for the market in enormous quantities, with particular emphasis on the materials used in the process equipment.

Also present at this meeting was ASTM Executive Secretary, R. J. Painter, who stopped en route to the West Coast on a combined business and vacation trip.

Plastics Featured at Technical Program of New England District

THE NEW ENGLAND DISTRICT planned its Fall meeting program around the Boston meetings of ASTM Committees D-9 on Electrical Insulating Materials and D-20 on Plastics, and made the subject of "Plastics" the topic of the evening's technical program.

The meeting, held on October 28 in Cambridge, Mass., following cocktails and dinner, featured two guest speakers, Dr. Ralph K. Witt, Chairman of Committee D-20, and Dr. Gordon M. Kline, a plastics expert, long well known in ASTM. Dr. Witt, who is Associate Professor of Chemical Engineering at Johns Hopkins University emphasized the field of engineering applications in discussing the subject of plastics; Dr. Kline, Chief of the Plastics Section and Assistant Chief of the Division of Organic and Fibrous Materials of the National Bureau of Standards, had just returned from meetings in Italy and Germany and was able to give his observations on developments in plastics in Europe.

Chairman of the program was Daniel Cushing who carried out arrangements for the dinner and meeting with the cooperation of H. H. Lester, C. G. Lutts, and R. W. Chadbourn, New England District officers.

President's Night at Pittsburgh District

101 ASTM MEMBERS and friends in the Pittsburgh area and members of the American Institute of Chemical Engineers took the opportunity on October 8 to meet Society President Harold L. Maxwell as President's Night guests of the Pittsburgh District.

A cocktail hour and dinner at the University Club preceded the technical meeting which featured Dr. Maxwell's talk, "Chemical Developments and Engineering Materials."

The honor accorded W. A. Selvig during the program by Committee D-5 on Coal and Coke is described on page 17.

Arrangements for this highly successful meeting were handled largely by District Chairman M. D. Baker, and Secretary H. F. Hebley.

At the Pittsburgh District meeting—H. L. Maxwell, M. D. Baker, and H. F. Hebley.

TECHNICAL COMMITTEE NOTES

Committee B-8 Holds Two-Day Meeting at Headquarters

ASTM HEADQUARTERS in Philadelphia was the scene of the two-day fall meeting, November 12 and 13, of Committee B-8 on Electrodeposited Metallic Coatings. Work in progress in the main committee and subcommittees was reported as follows.

The 1952 report of the committee included a recommendation for replacing decimal inches in all B-8 standards by mils and micron equivalents. As a result of arguments presented in two negative ballots, these recommendations were withdrawn and the specifications as they will appear in the 1952 Book of ASTM standards will maintain the use of decimal inches with the editorial addition of micron equivalents. The question of the use of mils has been referred back to the subcommittee for its consideration. Subcommittee IV on Electroplating Practices is making what is hoped will be the final revisions in the recommended practice for preparation of and plating on copper and copper alloys. A similar recommended practice for lead and lead alloys is progressing satisfactorily. A study of the variables involved in the preparation of cast and malleable iron for plating involves consideration of method of casting and foundry cleaning variables.

The section on preparation and plating of plastics is currently being reactivated and a progress report should be forthcoming in the near future. A new section is being established on alkaline cleaning techniques.

Preliminary work has been completed on accelerated tests on supplementary treatments of plated specimens and additional panels are being prepared for additional study. Panels are currently being prepared in connection with the work of the section of performance tests, and exposures will be made outdoors at Kure Beach, N. C., and at New York City and under simulated warehouse conditions at Kure Beach. A new section G on Lead Treatments has been created under the chairmanship of E. J. Roehl, Thomas Steel Co. Section E on Phosphate Treatments under the chairmanship of A. L. Alexander, U. S. Naval Research Laboratories, has obtained preliminary data on a broad program which includes effect of the amount of phosphate deposited over zinc coatings and standard methods of determining this thickness. A series of phosphated panels with four thicknesses of phosphate over zinc will be coated with a clear alkyd varnish and will be submitted to salt spray tests as well as outdoor exposure at the Canal Zone, Kure Beach, and Washington, D. C. Humidity cabinet tests will also be performed on a number of these panels. One of the fundamental studies involved will be that of the adoption of the organic coatings as applied to both phosphated and unphosphated panels.

Tentative studies by Subcommittee III on Performance Tests indicate that little or no reproducibility has been obtained among four salt spray test cabinets on nickel-chromium coatings on steel and that few of the panels met the requirements of ASTM Tentative Specifications for Electrodeposited Coatings of Nickel and Chromium on Steel (A 166). The present Section C on Adhesion Ductility and Hardness tests has been subdivided and a new Section E on Adhesion has been organized under the chairmanship of Fielding Ogburn of the Bureau of Standards.

Several recommendations of existing specifications are under consideration. In A 166 consideration is being given to the inclusion of an insert permitting coatings applied by chemical reduction methods. In Tentative Specifications for Electrodeposited Coatings of Nickel and Chromium on Zinc and Zinc-Base Alloys (B 142), it has been suggested that the minimum copper thicknesses be reduced to 0.0002 in. A section on differences and terminology is being reactivated.

The last set of lead-plated panels removed from the test racks has had weight loss measurements completed and tension tests are currently being made. In view of the low ratings of all the panels returned from Tela, Honduras, for inspection, it has been agreed that these panels will not be returned for additional exposure.

Controversey over a numerical rating system has existed for many years, and Section D of Subcommittee II has developed a rating system which shows promise of meeting a number of the objections previously raised. This system combines a weight index of the various types of corrosion and lists the defects in order of importance as follows: (1) peeling or flaking, (2) crater rusting, (3) blisters, (4) pinhole rusting, (5) crowsfeet, (6) moderate to heavy surface pitting, (7) dark stain, (8) light iridescent stain of surface pitting.

The latter two have been given equal weight in the index and are the least objectionable.

Dr. Saltonstall, liaison member between Committee B-8 and AES Research Project No. 15 reported on a proposed AES program designed to develop more satisfactory tests for plated coatings. In this program panels having a tapered deposit will be mounted on the front license brackets of a fleet of taxis in Detroit for the winter. Both die-cast alloys and rolled steel will be used as basis materials in its panels. During the past winter 40,000 tons of salt were used by the city to aid in the removal of $58\frac{1}{2}$ in. of snow.

Much Activity Reported at Fall Meeting of Cement Committee

CULMINATING a series of productive subcommittee meetings, Committee C-1 on Cement held its regular Fall meeting October 31 at Philadelphia's Bellevue-Stratford Hotel. This meeting also marked the 50th Anniversity of the committee. Harry F. Gonnerman was recognized for his many years of service on the committee by election to honorary membership.

A new project was authorized through the organization of a working committee on properties of slag cement with Frank Jackson as chairman. This subcommittee will develop data to be used for the possible development of a specification. The advisability of recommending a certain type of mixer to be used in methods involving mechanical mixing was discussed with final decision resting with the Working Committee on Coordination of Methods. In the field of chemical analysis, round-robin tests on correct nitrogen content on Darex samples are being held in abeyance pending more information needed on nitrogen contents. The use of other types of flame photometers than now

prescribed in the standard method is still under review. The development of a method of analysis for manganese removal is still in progress.

In the study of consistency as related to volume change, it was reported that data on mortar bars with two consistencies, both having high alkali content, were being reviewed. Efforts are being made to coordinate the test method for time of set with that prescribed in Federal specifications. It was announced that cooperative tests have been completed on the measurement of heat of hydration and that a new Federal specification has included the alternate method. Revisions were approved in the Tentative Method of Test for Bleeding of Cement Pastes and Mortars (C 243), which will change the batch portions from 1:3 to 1:2½, provide further refinement in the mixer description, and add a provision for a sponge rubber mat or the equivalent to serve as a vibration damper.

Recommendations were made to the Sponsoring Committee on Portland Cement with respect to correcting the difference in limits of SO_3 content as specified in C 150 and C 175. Data from 13 plants on optimum amounts of gypsum were reviewed and a summary will be circulated to all committee members. A newly revised method for measuring air content of plain portland cement mortar will be studied. Meanwhile, revisions were approved in the present method (C 185) involving further refinement of apparatus, mechanical mixing, and reproducibility factors.

A recommendation was made for the immediate adoption of the revision of the Standard Specifications for Portland Cement (C 150), which will change the maximum air content from less than 15 to less than 12 per cent. All present tentative revisions of C 150 were recommended for adoption as standard. The Tentative Specifications for Air Entraining Portland Cement (C 175) were also recommended for adoption as standard. Revisions were approved for immediate adoption, subject to letter ballot, in the Standard Specifications for Masonry Cement (C 91), which will provide agreement in testing procedure with that outlined in the Standard Method of Test for Compressive Strength of Hydraulic Cement Mortars (C 109). After considerable discussion of two alternate recommendations presented for providing an autoclave expansion limit in Specifications C 91, a recommendation was accepted which will provide a limit of 1 per cent expansion as measured by the autoclave at seven days.

Recommendations were accepted for revisions in the Tentative Specifications for Portland Blast-Furnace Slag Cement (C 205), which will replace the existing setting time requirement with respect to final set from 10 to 7 hr, with the Vicat needle method only specified. Consideration is still being given to specifications for fly ash and fly ash portland cement, coordinating with Committee C-9. In the development of pozzolan calcined cement, it was the opinion of the sponsoring committee that one portland pozzolan specification to cover all purposes will be desirable, and this work is being initiated.

Comprehensive Review of Concrete Research Urged on C-9 Members

At its October meeting in Philadelphia the members of Committee C-9 on Concrete and Concrete Aggregates, were urged to review constantly the entire field of concrete testing and research to insure that no subjects were being overlooked. It was suggested that programs be arranged at the committee meetings for the presentation of informal papers presenting new ideas and new methods.

A review of the subcommittee reports revealed a number of items of interest. Plans are being made for presentation of technical papers at the 1953 Annual Meeting emphasizing significance of tests. Cooperative tests for establishing reproducibility between methods for measuring alkali reactivity, developed by A. D. Conrow and C. H. Scholer, using three aggregates and three cements of different alkali content, has resulted in reasonable reproducibility for both methods. In this connection it is planned to study aggregates now considered unsatisfactory in order to learn how to use such sources. A proposed method of test is being considered to measure pulse velocity, for reference purposes only, in connection with dynamic testing of concrete.

A proposed new method of test for lightweight pieces in aggregate was accepted for committee letter ballot to replace the present Standard Method of Test for Coal and Lignite in Sand (C 123). Agreement has not yet been reached on a specification for lightweight aggregate to replace the present standard (C 130). Three task groups have been designated in this subcommittee to report on various uses of light aggregates, classifying these uses into three groups, namely, insulating concrete, structural concrete, and concrete masonry units.

Data are still incomplete on a cooperative investigation to establish a new method of test for liquid membrane-forming compounds. A proposed specification for such compounds is still under consideration. A method for chemical analysis was agreed upon, to be included in a proposed test method for fly ash. Data on cooperative tests on ready-mixed concrete, sponsored by the Ready Mixed Concrete Assn., were reviewed. The subjects of wash water and overloading of trucks received attention in the subcommittee, and several of these problems will be circulated to the subcommittee for comment. Revision to the Tentative Method of Test for Bleeding of Concrete (C 232 T) was accepted to provide a method of computing bleeding in terms of volume per unit area.

No data are available as yet on a cooperative series of tests covering two types of measuring abrasion of concrete. Many phases are being explored on the subject of measuring setting time of hardened concrete, including the entire range of mixing and placing times, sonoscope tests and such factors as heat of hydration, electrical conductivity, change in air content, and bleeding characteristics. A fourth method of freezing-and-thawing tests involving slow freezing in air and thawing in water was accepted for committee letter ballot.

Much Standards Work at C-16 Fall Meeting

The Homestead at Hot Springs, Va., was the scene of the Fall meeting of Committee C-16 on Thermal Insulating Materials on October 27 to 29. In spite of the many outdoor attractions of this resort hotel, an intensive schedule of meetings was maintained to take care of the business outlined.

The death of Secretary H. G. Hill in April made it necessary to appoint a new secretary to fill in the unexpired term and chairman Queer tentatively named W. L. Glantz, American Viscose Co., to this position. R. R. Sullivan, Wood Conversion Co., was appointed as the new chairman of Subcommittee S-II on Structural Insulating Board, replacing S. M. Van Kirk. W. D. Stevens, Babcock & Wilcox Co., and H. E. Lewis, Industrial Mineral Wool Inst., were

confirmed as chairmen of Subcommittees S-I, Block and Pipe Insulation, and S-VI, Blanket Insulation, respectively. A plan was adopted for automatic rotation of subcommittee chairmen on a staggered basis among the subcommittees at the end of each two-year term, with a duly elected secretary of each subcommittee to be considered as the successor to the retiring chairman.

The subject of fire tests on thermal insulating materials received considerable attention, especially in Subcommittees S-II and S-IV. Discussion revolved around proposed use of the test procedure, with some modifications, as prescribed in Federal Specification SS-A-181. A proposed method of test for determining flame resistance of interior finish materials was reviewed in Subcommittee S-II but was not approved for further promulgation pending the acquisition of more data. A task group was authorized in Subcommittee S-II to study four points of issue in respect to the proposed method presented to the subcommittee. A task group was also authorized in Subcommittee S-IV for the purpose of correlating with Subcommittee S-II, and any other subcommittee, on a test method to determine the comparative fire resistance of thermal insulating materials.

In the field of block and pipe insulation proposed methods for testing vibration resistance and for sampling of preformed thermal insulation for pipes were approved for committee letter ballot. A proposed racking load test method for structural insulating board is now ready for letter ballot of the subcommittee. Two proposed tentative methods of tests for adhesion and compressive hardness of thermal insulating cements were reported as completed and ready for letter ballot of the committee pending approval by the Editorial and Significance of Tests Subcommittees. The properties of plasticity and wet adhesion are now receiving attention, and test data were reviewed preliminary to the development of proposed test methods.

In order to stimulate activity in the development of test methods on loose fill insulation, a tentative specification will be prepared. Various representative groups such as the National Mineral Wool Assn., Perlite Inst., and the Vermiculite Inst. will be contacted for ideas. Properties for which test methods were felt desirable include density, moisture resistance, and corrosion or disintegration. Standard samples of granulated wool, perlite, and vermiculite will be sent to three member laboratories for cooperative tests.

The proposed method of test for thermal conductivity of pipe insulation is now ready for subcommittee ballot. It is also planned to submit the latest draft of a revision of the method of test using the hot box apparatus (C 236), less the significance of test statement, to subcommittee letter ballot. A task group is reviewing the present method of test using the guarded hot plate apparatus (C 177) to establish the need for revision. A study of low-temperature apparatus has also been suggested.

Four items dealing with special thermal properties were reviewed. The results of a second round-robin test series on specific heat were reviewed in which the precision of tests has not yet been satisfactory. Three methods are being considered for measuring heat reflectance or emissivity of reflective type insulation. The other two items receiving attention in this group are a volume change or shrinkage method and a method of test for a maximum use limit of high-temperature insulations. A proposed recommended practice for clearance of preformed thermal pipe insulation was submitted to the committee for letter ballot. It was reported that a proposed method of test for water vapor transmission of thermal insulating materials greater than 1 in. thickness is now in process of subcommittee letter ballot.

The research program sponsored by the committee for the establishment of a method of testing the effects of moisture on thermal conductivity of insulation materials has been financially supported to the extent that work is expected to start in the very near future. Preliminary laboratory work carried on by private companies has shown promise for a solution to this difficult subject. This work will be conducted at Pennsylvania State College.

A proposed change in the scope of the committee was presented to include coating materials associated with thermal insulating materials. Two amendments to the By-laws had their reading, one dealing with stricter requirements for maintenance of membership in respect to answering letter ballots, the other amplifying the privileges of associate members.

A dinner for the entire committee was held on October 28, at which time opportunity was again provided for ex-Chairman Ray Thomas to exercise his usual ability of introducing all members and visitors present by memory. The next meeting of the committee will be held in connection with Spring Committee Week in Detroit.

Porcelain Enamel Committee Preparing Annual Meeting Symposium

PORCELAIN Enamels and Ceramic Coatings as Engineering Materials is the subject of a comprehensive symposium which is being developed by Committee C-22 on Porcelain Enamel. At its meeting in Columbus, Ohio, on October 9 and 10, the special symposium subcommittee reported that sixteen papers had been tentatively accepted to form a program occupying two sessions at the 1953 ASTM Annual Meeting. It is planned to divide the symposium into three parts covering structural, high-temperature, and chemical and physical properties. Offers of papers were received as a result of an industry-wide survey, in which a questionnaire solicited an expression of interest in a list of high priority topics and the desire to have information on them.

The committee members were guests of Battelle Memorial Institute at this Columbus meeting. Some of the highlights of the work of the subcommittees, all of which met, are presented here.

Subcommittee I on Research will continue its interest in obtaining data on thermal shock, observing several projects which are in progress at the present time outside of the committee. A task group will survey all available information and contact laboratories now interested in thermal shock tests for the purpose of collecting data from which standard test methods may be developed. It is felt that test methods will be required for each end use product. Continued attention will be given to the effect of elevated temperature on porcelain enamels and ceramic coatings, with B. J. Sweo assuming chairmanship of this task group.

Subcommittee II on Nomenclature reviewed comments received on terms included in a proposed glossary. This review is not completed and will be carried over into the next meeting of the subcommittee. All members were urged to standardize on the use of the term "porcelain" to precede the term "enamel" whenever the latter term is used.

Fourteen projects for the development of standard test methods are in process in *Subcommittee III on Tests*. The work of the subcommittee is divided into two parts: raw and processed material; and finished products. In various stages of development in the first group are proposed standard methods for measuring reflectivity, coefficient of scatter, tearing, sagging, water analy-

sis, consistency, torsion, and fusion. The section on finished products has completed proposed test methods for measuring warpage and reflectance, the latter test having also been submitted to ASTM Committee E-12 on Appearance. Correlation data between 45 and 60 deg angle for measuring gloss will be made available to the committee. Considerable attention is being given to the development of an abrasion test method which might be acceptable to the industry. Further revisions of an existing PEI test method will be studied. Other proposed test methods are in process of development dealing with measuring thickness, adherence, acid and water attack on chemical ware, scratch, continuity of coating, and metal marking.

Why Am I an ASTM'er?

ASTM HEADQUARTERS files contain hundreds of letters embodying statements by our members on why they value ASTM. Many of these communications are copies of letters used by our members in following up membership invitations. Some of these, setting forth succinctly the reasons why men prominent in U. S. technology are in ASTM, have been used from time to time in the BULLETIN.

From a New England Executive—

". . . We have held membership in ASTM for several years. . . . As a container manufacturer we derive great benefit from our membership. I don't know enough about your business to offer much advice but I wouldn't think any architect, prospering and constantly concerned with the best in construction, could afford not to join the ASTM. Many bulletins are at your disposal; they can always help in personal matters, and when it comes to standardization they are tops. Why don't you join and use them, and get your money back many times over? . . ."

D-9 Holds Joint Meeting with D-20 in Boston

COMMITTEE D-9 on Electrical Insulating Materials held a joint meeting with Committee D-20 on Plastics in Boston on October 29–31 preceded by those of D-20 on October 27–29. In addition to the Advisory and Main Committee meetings there were also meetings of 30 subcommittees and sections. Many of the projects under consideration in the committee were advanced at this series of meetings.

Subcommittee I on Insulating Varnishes reviewed the extensive revision of the Tentative Methods of Testing Varnishes Used for Electrical Insulation (D 115) which had been approved by committee letter ballot. These methods include both composition and performance tests and are intended for varnishes used for electrical, mechanical, and chemical protection of electrical equipment. These revised methods will be submitted to the Society through the Standards Committee. One of the most active projects covers the development of test methods for silicone varnishes. Round-robin tests are under way on tests for dielectric strength, draining time, time of drying, heat flexibility and stability, weight loss, and oil resistance. A definition of an electrical varnish is in preparation. A new Section on Significance of Tests and Definitions is being organized and will consider the various tests applied to insulating varnishes.

The Subcommittee on Molded Materials considered revisions in three tentatives that will shortly be submitted to the Standards Committee. These cover changes in the Tentative Specifications for Phenolic Molding Compounds (D 700 – 49 T) and Tentative Specifications for Nonrigid Polyvinyl Tubing (D 922 – 47 T) and in the Tentative Methods of Testing Nonrigid Polyvinyl Tubing (D 876 – 51 T). In the latter method the lengthwise shrinkage test is being deleted as this has now been replaced by the stress deflection test; also a revision of the dielectric stress test at high humidity is included. New specifications for plastic tubing for high temperature service are in preparation. The committee is reviewing the various test procedures in the Standard Methods of Testing Laminated Tubes Used for Electrical Insulation (D 348) and Standard Methods of Testing Laminated Round Rods Used for Electrical Insulation (D 349).

The Subcommittee on Liquid Insulation held meetings on two days with an attendance of 45 members and guests. The numerous sections of this subcommittee have been especially active and considerable progress was made on a number of the problems under consideration. Plans were made for sponsoring another Symposium on Insulating Oils at the Spring, 1954, meeting. The Symposium on Insulating Oils, held at the November, 1951, meeting, is now available as *Special Technical Publication No. 135* from ASTM Headquarters. This symposium comprises the following three papers:

Introduction by L. B. Schofield
Evaluation of Mineral Transformer Oil During Service. Part II: Correlation of Oil Characteristics with Continued Transformer Operation by F. M. Clark
Evaluation of Mineral Transformer Oil During Service. Part III: An Examination of Selected Transformers by R. G. Call, F. M. Clark, and T. A. McConnell

The Section on Sludge examined test data on the repeatability and reproducibility of the Tentative Methods of Test for Sludge Formation in Mineral Transformer Oil (D 670–42 T). As a result consideration will be given to proposing this method as standard in whole or in part during the year. Studies of uninhibited oil in service are being continued. The draft of a new method for determining water in insulating oil by extraction has been prepared and will be studied by cooperative tests. The Karl Fischer method for determining water in oil by the colorimetric or electrometric procedure is still under study. Action was taken to submit a new test for corrosive sulfur in insulating oils to letter ballot of the subcommittee. A new section to study circuit breaker oils was authorized.

The Subcommittee on Ceramic Products considered proposals that work be undertaken on standardization of tolerances for steatite used in cathode and radio tube manufacture. The possible need for specifications for porcelain insulators was also discussed, and it was decided to make a survey of existing standards for these materials.

The new *Section on Polymerizable Casting Materials* held an organization meeting in New York on October 17. Excellent progress was made in developing a program of work.

The *Subcommittee on Insulating Fabrics* submitted revisions in the Tentative Methods of Testing Pressure-Sensitive Adhesive Tapes Used for Electrical Insulation (D 1000 – 48 T). The revision provides for a change in the temperature from 77 F to the standard laboratory temperature of 73.4 F. Also the type and grade of steel strips used in the adhesion test are to be omitted. The design of the roller for the adhesion strength test will be changed. The Tensile Strength Method for Determining Electrolytic Corrosion, now published as an appendix to D 1000, was

recommended to be deleted as this procedure, which had been included as information only, has been found to be inferior.

The Tentative Methods of Testing Varnished Glass Fabrics and Varnished Glass Fabric Tapes Used in Electrical Insulation (D 902 – 50 T) were recommended for adoption as standard with a minor change providing for use of foil electrodes. Specifications are in preparation for oil used in the preparation of oil-packed tapes. Studies are under way of a cold temperature test for glass fabrics, also Specifications for Treated Sleeving are in preparation.

It was announced that work is to be undertaken on the development of test methods for rubber-coated fabrics used as electrical insulation. This work will be coordinated with that now under way on these materials in Committee D-11 on Rubber and Rubber-Like Materials.

The *Subcommittee on Mica Products* reviewed the revisions recently voted on in the Tentative Specifications for Natural Muscovite Mica Based on Visual Quality (D 351 – 49 T). It was decided to make an important change in the revision as regards the reference to be included to the reference standards for visual quality of natural muscovite mica. Agreement was reached on a set of master standards for waviness only representing the full range of wave variations for visual quality levels of mica of good stain and better. At the present time only one master set of the waviness standards has been selected by a Task Group. Action was taken to submit this further change in Specifications D 351 to immediate simultaneous letter ballot of Subcommittee IX and Committee D-9.

The *Subcommittee on Electrical Tests* received a report from its Section on Power Factor of Solid Insulation recommending an extensive revision of the Tentative Methods of Test for Power Factor and Dielectric Constant of Electrical Insulating Materials (D 150–47 T). Another section reported considerable progress on a complete revision of the Standard Methods of Test for Dielectric Strength of Electrical Insulting Materials at Commercial Power Frequencies (D 149 – 44). Another section is undertaking study of tests for dielectric constant of gasoline.

New Standards Prepared by Plastics Committee

COMMITTEE D-20 on Plastics and 15 of its subcommittees held productive and well-attended meetings in Boston on October 27 to 29. At the conclusion of the meetings the subcommittee on Research sponsored a technical session at which the following three papers were presented:

Utility and Significance of Statistical Indices, by Rogers B. Finch, Massachusetts Institute of Technology

Relaxation Stiffness Tester, by F. C. Dexter, Bakelite Co.

Accelerated Exposure Techniques, by L. Boor, Philadelphia Quartermaster Depot

A new proposed Tentative Method of Test for Shrinkage of Thermosetting Plastics at Elevated Temperatures was completed at the meeting and action taken to submit it to letter ballot.

The Subcommittee on Specifications submitted three recommendations for committee vote. The first covers new Tentative Specifications for Nylon Plastic for Injection Molding and Extrusion Compositions. These specifications had been under active study by the committee for the past two years. The second covers new Tentative Specifications for Laminated Thermosetting Decorative Sheets. The third recommendation involves revisions of Standard Specifications for Vinyl Chloride-Acetate Resin Plastic Sheets (D 708 – 50).

The Subcommittee on Nomenclature and Definitions submitted definitions of the following terms: polyester plastics, alkyd plastics, halocarbon plastics, resin, volatile loss, and pseudo-stable.

At the meeting the committee reviewed the results of a recently completed letter ballot on seven recommendations which will be presented to the Society through the Administrative Committee on Standards. These cover the following subjects:

A new Tentative Method of Test for Abrasive Resistance of Plastic Materials (Mechanical Effect) for determining resistance to abrasion of flat surfaces of plastics measured in terms of volume loss by two different methods, (1) loose abrasive, and (2) bonded abrasive on cloth or paper.

An extensive revision of the Standard Method of Test for Resistance of Plastics to Chemical Reagents (D 543 – 43) which will be reverted to tentative. This method of test includes provisions for reporting changes in weight, dimensions, and appearance, but does not cover changes in strength properties, electrical characteristics, and the like.

New Tentative Specifications for Primary Octyl Phthalate Ester Plasticizers, which is the first of a series of contemplated specifications for plasticizers used in the compounding of plastics. This first specification covers the following three types of plasticizers: Normal Octyl Phthalate Ester, Ethyl Hexyl Phthalate Ester, and Mixed Iso-Octyl Phthalate Ester.

New Tentative Specifications for Polyethylene Molding and Extrusion Materials include requirements for six grades and two types of polyethylene which are finding increased use. They were prepared after thorough study and discussion of the characteristics and properties of this material which is used extensively in high-frequency electrical insulation (coaxial cables, etc.).

A new Tentative Method of Test for Specific Viscosity of Primary Vinyl Chloride Polymers. In this test a sample of resin is weighed accurately and dissolved in nitrobenzene. The specific viscosity is calculated from the ratio of the kinematic viscosity of a specified solution of the polymer to the kinematic viscosity of the solvent.

The final recommendation covers a revision of the Tentative Specifications for Phenolic Molding Compounds (D 700 – 49 T). It comprises changes in the verbal description of five types and revisions in requirements for certain physical and electrical properties of seven types of phenolic molding compounds.

Performance Standards Keynote Shipping Container Committee Meeting

WITH the emphasis now being placed on performance standards and correlation of data, it has become evident in Committee D-10 on Shipping Containers that there is need for closer coordination of activities among the several subcommittees concerned with test methods. This was brought out at the fall meeting of the committee held September 16 and 17 at the Hotel Bismarck, Chicago, Ill. It is planned to hold a joint meeting of the chairmen of the three subcommittees involved at the next meeting of the committee for the purpose of outlining a coordinated program to facilitate the development of performance standards.

A good attendance, numbering 52, was present at the meetings, which were held in conjunction with the meeting of the Society of Industrial Packaging Engineers. Two features of the fall

meeting were a panel on impact recorders and a field trip to the Signode Steel Strapping Co. The panel consisted of four members who discussed the historical background and development of the impact recorder, experiences in its use, and the need for improvement of this type of apparatus as a means of load evaluation and measurement of the ability of shipping containers to protect contents under severe shipping conditions. An exhibit was shown of seven types of recorders which have been developed over a long period of time, originating in 1908.

The highlights of the several subcommittee reports are summarized briefly in the following statements: *Subcommittee I on Definitions of Terms* recommended for consideration of the entire committee definitions of the terms "packing," "packaging," and "package." In *Subcommittee II on Methods of Testing*, a task group is occupied with the development of a test procedure to measure the puncture resistance of multiwall shipping sacks. It has been extremely difficult to establish a procedure which is reproducible, and further recommendation is being delayed until the spring meeting. A study of the vibration test (D 999), using an oscillograph, discloses very little difference in vibration between the points of measurement on tall and short test packages. A new task group will study the present revolving drum test (D 782) for the purpose of eliminating or minimizing certain instrumental and operational variables. It was announced that a new drop test apparatus is being designed by Acme Steel Co., the drawings of which will be available inasmuch as the company does not intend to manufacture and merchandise the new equipment.

Revisions were considered and approved by *Subcommittee III on Moisture and Water Vapor Resistance* to the proposed Tentative Method of Test for Water Vapor Permeability of Packages by Cycle Method. Task groups of *Subcommittee IV on Performance Standards* reported on vibration test studies which are still incomplete; a recommended stacking test to be performed on the same package of merchandise as used in the other tests of the proposed cycle; no progress on the correlation between the drop and inclined-impact test; and investigations on the drop test method.

Subcommittee V on Correlation of Tests reported increased activity in the drop test method, with two additional laboratories to participate with the four present laboratories on a supplementary round-robin series of tests. The subcommittee has recommended that the drop test method be reviewed by Subcommittee II for the purpose of further necessary refinement.

Subcommittee VI on Interior Packing plans to develop a tentative method of load deflection for determination of energy absorption of cushioning material, as well as to develop a method for determination of compression of cushioning material. Additional definitions of terms relating to vibration will be completed, and contact and liaison will be maintained with current shock absorption investigations under way in other organizations.

The next meeting is planned for April 22 and 23 in Chicago in connection with the AMA National Packaging Exhibit.

Committee D-2 on Petroleum Products and Lubricants

Summary of Committee Work for Last Year and a Review of Work Planned for the Year 1952–1953

In June the working committees of ASTM Committee D-2 on Petroleum Products and Lubricants presented reports to the committee which summarized the work done in the past year and gave a short picture of activities planned for the coming year. These reports have been condensed and are presented herewith.

Technical Committee A on Gasoline, H. M. Smith, chairman, has revised ASTM D 439, Specifications for Gasoline in the following respects: Research Method octane number (D 908) has been adopted to replace the Motor Method octane number (D 357) previously specified. On the basis of the Winter 1951–1952 Bureau of Mines Survey, Research octane numbers of 78 minimum for regular, and 85 minimum for premium-price gasolines have been selected. In addition, the Appendix of the Specification has been rewritten to include significance of test information with regard to Research and Motor Method octane numbers.

During the past year Technical Committee A has been reorganized to include the following sections:

Section I Specifications, J. M. Campbell, chairman
Section II Volatility, R. C. Alden, chairman
Section III Gum and Varnish, S. S. Kurtz, Jr., chairman
Section IV Sulfur and Corrosion, P. C. White, chairman
Section V Anti-Knock Value, F. C. Burk, chairman
Section VI Tetraethyllead, C. M. Gambrill, chairman
Section VII Storage Stability, W. R. Power, chairman

Section VII has studied data on storage stability of gasolines, and has prepared a report showing the correlation of the data with data on gasolines tested by ASTM Method D 525, Test for Oxidation Stability of Gasoline (Induction Period Method).

Technical Committee B on Lubricating Oils, W. S. James, chairman, has an active work program under way in Section U-III on Industrial Gear Oils, C. L. Pope, chairman, and in Section U-V on Instrument Oils, E. H. Erck, chairman. Section U-V has test programs in progress investigating performance, spreading, corrosion, and oxidation characteristics of instrument oils.

The special study committee, C. G. A. Rosen, chairman, formed in February, 1951, to work with the Lubrication Committee of the Division of Marketing, American Petroleum Institute, in developing a use classification for automotive engine lubricating oils, has carefully studied the "API Service Classifications and Designations for Lubricating Oils for Automotive Type Engines."

A Special Subcommittee on Railway Car Journal Lubrication was formed, with J. J. Laudig as chairman.

Section I on Oiling Systems, F. E. Rosenstiehl, chairman, of *Technical Committee C on Turbine Oils*, F. C. Linn, chairman, plans a study of the rusting of turbine oil systems in service. The section also acts as a joint ASME-ASTM Committee on Turbine Lubrication and, in this capacity, is continuing studies preparatory to issuing "Recommended Practices on Design of Turbine Lubricating Systems," and "Preparation of Turbine Lubricating Systems for Layup."

ASTM Method D 665, Test for Rust-Preventing Characteristics of Steam-

Turbine Oil in the Presence of Water, was revised this year. Further revisions to D 665 and to ASTM Method D 943, Test for Oxidation Characteristics of Inhibited Steam-Turbine Oils, are planned.

Work is continuing on rotary-bomb oxidation tests to determine oil life. Other projects include the correlation of neutralization values with peroxide content, the development of emulsion tests, and the preparation of a report on the compatibility of new and used turbine oils.

Technical Committee F on Diesel Fuels, W. K. Simpson, chairman, is continuing to study ASTM D 975, Classification of Diesel Fuel Oils, in order to keep the classification in line with the requirements of the modern day diesel engine. A method for estimating cetane numbers has been appended to the classification this year as information only.

The committee will attempt to develop a test to differentiate wax cloud point of diesel fuels from water or moisture cloud point.

Technical Committee G on Lubricating Grease, R. C. Adams, chairman to June, 1952, J. M. Bryant, present chairman, completed long-term projects on a study of thixotropic properties of lubricating greases; and on the study of new methods for the determination of lead in greases, and the effect of grease on copper.

Data were collected for the establishment of a high-temperature performance tester and a wheel bearing grease tester as items of standard equipment.

ASTM Method D 217, Test for Cone Penetration of Lubricating Grease, was revised to include new specifications for the penetrometer and a method for testing greases worked more than 60 strokes.

A study will be made to develop improved methods for the chemical analysis of constituents of grease not covered by ASTM D 128, Methods of Analysis of Grease.

Study will be made of low-temperature measurements of grease, and oil separation of grease.

Technical Committee G sponsored the ASTM Symposium on Fretting Corrosion held during the 50th Anniversary Meeting of the Society.

Technical Committee H on Light Hydrocarbons, W. G. Lovell, chairman, cosponsored a Symposium on Analytical Methods in the Manufacture and Utilization of Butadiene in cooperation with the Synthetic Rubber Division of the RFC. The symposium, held in Washington on February 6, 1952, in conjunction with the ASTM Committee D-2 meeting, was well received and consisted of the following ten prepared papers:

Determination of Individual Acetylenes in Butadiene and in C_4 Hydrocarbons, by R. F. Robey, B. E. Hudson, Jr., and H. K. Wiese.

Determination of Acetylenes in Specification Butadiene, by R. E. Hyzer.

Ultraviolet Spectrophotometric Method of Analysis for p-Tertiary Butyl Catechol, by G. G. Campbell and Shirley A. Tacker.

A Comparison of Two Procedures for the Determination of Tertiary Butyl Catechol in Butadiene, by J. B. Hutto, Gerald Millslagle, and H. D. Maples.

Carbon Dioxide Scrubbing Method for the Determination of Light Hydrocarbons in Water, by L. A. Webber and C. E. Burks.

Routine Determination of C_4 Hydrocarbons in Furfural or Absorber Oil, by R. E. Hyzer.

The Manganous Hydroxide Method of Test for Oxygen in Butadiene Vapors, by Grant W. Taylor.

Sulfur in C_4 Hydrocarbons by the Lamp Method, by E. R. Sadler.

A Testing Method for Regenerative Dehydrogenation Catalyst Used in the Production of 1,3-Butadiene from N-Butene, by R. W. Roberts, R. F. Lind, C. R. Noddings, and A. J. Dietzler.

A Differential Refractometer for Process Control, by E. C. Miller, B. J. Simmons, and F. W. Crawford.

Seven of the ten papers were published in the July, 1952, issue of "Analytical Chemistry."

Specific gravity tests, copper strip corrosion, and water methods for liquefied petroleum gases are under consideration.

The Natural Gasoline Association of America will be asked for recommendations relative to possible issue, as ASTM Methods, of the commercial propane residue test (mercury freeze test) and the LPG weathering test.

Liaison with the Natural Gasoline Association and with ASTM Committee D-3 on Gaseous Fuels will be continued, so that all actions of Technical Committee H will be acceptable to, and meet the needs of producers and consumers of light hydrocarbons.

Technical Committee J on Aviation Fuels, J. T. Hendren, chairman, is continuing the study of the performance of aviation fuels in order to keep its activity in step with latest developments. A new grade, to be designated Grade 108/135, is under active consideration.

Increasing emphasis on jet propulsion fuels is showing in the work of Technical Committee J. Section VII on Jet Fuels, A. B. Cramption, chairman, has laboratory tests for the filterability of jet fuels under consideration, and also plans to study smoke point tests for jet fuels.

Section II on Detonation, E. A. Droegemueller, chairman, is continuing cooperative work with the Armed Services-Industry Cooperative Group. Work on fuel rating by this group shows progress.

Technical Committee K on Cutting Fluids, E. M. Kipp, chairman, has an active program under way in Sections I on Laboratory Evaluation of Cutting Fluids (L. H. Sudholz, chairman), II on Plant Evaluation of Cutting Fluids (M. E. McKinney, chairman), and III on Nomenclature (O. W. Boston, chairman).

Publication of a report is anticipated giving the results of a testing program involving Federal Stock Specification VV-O-283, Determination of Active Sulfur in Cutting Oils.

The committee is continuing study of flank wear and finish properties tests, film-strength testers, and methods for the stability of water emulsions of soluble oils and rust-preventing characteristics of water emulsions of soluble oils.

Two special sections are being considered, one to explore possible methods for surveying industrial practices in the selection and application of cutting fluids, the other to provide consulting services to Technical Committee K groups on the statistical planning of laboratory test programs and on evaluating cooperative test results.

Technical Committee L on Tractor Fuels, E. M. Hughes, chairman, prepared the new Tentative Definition and Specifications for Tractor Fuels (D 1215–52 T).

Technical Committee M on Petroleum Wax, A. M. Heald, chairman, which functions as a joint TAPPI-ASTM Committee, completed a test method for tensile strength of paraffin wax which is being published as information.

This joint committee has the following additional test methods for wax under study: bending, penetration, accelerated oxidation and direct oxygen absorption, odor, oil content, blocking, sealing strength tests, and tests for scuff and gloss of wax surfaces.

Research Division I on Combustion Characteristics, F. C. Burk, chairman, completed, during the past year, a test program directed at improving reproducibility of knock ratings by elimination of the effects of barometric pressure variations. Systems which had been developed for pressurizing Motor, Research and Aviation Method engines were tested in the altitude chamber at the National Bureau of Standards. Development of a pressurized carburetor will continue, and other approaches to the solution of the problem will be investigated.

The redesigned High-Speed Crankcase, designated CFR-48, was approved for use with the Motor, Research, Aviation, Supercharge, and Cetane Methods

(D 357, D 908, D 614, D 909, D 613).

An article on "Knock Rating of Small Samples," by R. H. Stacey was published in the ASTM BULLETIN February, 1952, containing information on the development of the micromethods for knock rating small samples. (Three micromethods were published in the 1951 "ASTM Standards on Petroleum Products and Lubricants" as information.) A micromethod has been applied to the detection of impurities in *iso*octane and *n*-heptane. A 0.1 octane number impurity in *iso*octane and a 0.2 octane number impurity in *n*-heptane, when blended 50/50 with *iso*octane, can be detected.

An engine procedure will be prepared by which impurities can be detected in *iso*octane and *n*-heptane, within the specified limits.

Investigation of new ignition delay measuring instrumentation for use in the Cetane Method (D 613) was prosecuted. The Institute of Petroleum (United Kingdom) laboratories joined in part of this work. Efforts to improve the Supercharge Method (D 909) included recommendation of hard-faced (Eatonite) exhaust valves, as well as investigation of valve rotators, electrical ignition system, experimental knockmeter, and chromium-plated cylinders, and spark plugs. Efforts to improve Methods D 613 and D 909 in equipment and instrumentation are continuing. A summary on "Knock Rating Instrumentation" by Josiah French appears in the ASTM BULLETIN, July, 1952.

A new edition of the ASTM Manual of Engine Test Methods for Rating Fuels, which has just been published, brings all five methods and the extensive supplementary information up to date. An index has been included in the new Manual.

A "check out" fuel was established for the Aviation (D 614) and Supercharge (D 909) methods. A more accurate calibration of leaded primary reference fuels, used as engine standardization fuels on the Motor (D 357) and Research (D 908) methods was obtained.

Development of new check fuels, comprised of pure hydrocarbons, for Motor and Aviation knock test methods was initiated and is continuing.

The Division is attempting to develop micrometer guide curves for the Motor and Research methods for use in rating fuels from 100 octane number up to *iso*octane plus 3 ml of TEL per gal.

A report is planned outlining the precision of fuel rating for the years 1947 to 1951, inclusive.

Division II on Measurement and Sampling, L. C. Burroughs, chairman, witnessed the completion of two very large projects during the year—ASTM-IP Petroleum Measurement Tables and Method of Calibrating Upright Tanks (D 1220–52 T).

The first of these has been under way since 1946 with the co-sponsorship of the Institute of Petroleum (United Kingdom) and consists of petroleum measurement tables based on the three most widely used systems of measurement—U. S. units, British (Imperial) units, and Metric units. The tables will appear in three volumes, which are interrelated, to meet the world-wide need for uniform and authoritative publication to serve as a basis for standardized calculations of measured quantities of petroleum, regardless of point of origin or destination. Close contact is being maintained with the Institute of Petroleum, for coordination of methods of measurement and sampling.

The preparation of the method for calibrating liquid containers larger than a drum has been going on for over five years and is the result of considerable study of available information on tank calibration. Methods for calibrating other types of containers will be prepared.

Methods contained in the "ASTM Manual on Measurement and Sampling of Petroleum and Petroleum Products" underwent revision. A method for sampling liquefied petroleum gases has been included.

Two new sections were formed: Section B on Gravity, J. G. Detwiler, chairman; and Section H on Water and Sediment, C. H. Lynam, chairman.

Research Division III on Elemental Analysis, C. M. Gambrill, chairman. All sections have been active during the year.

A method for the determination of mercaptan sulfur in jet fuels (color-indicator method) (D 1219–52 T) was issued as Tentative.

Section A on Determination of Sulfur, B. J. Heinrich, chairman, is continuing a study of methods for determining sulfur in liquefied petroleum gases and butadiene.

Section B on Determination of Chlorine, R. C. Mallatt, chairman, is continuing a study of quartz-tube combustion and sodium peroxide fusion methods for chlorine in oils and greases.

Section D on the Determination of Metals, W. C. Woelfel, chairman, is studying volumetric and colorimetric procedures for the determination of barium calcium and zinc in new oils.

Section E on Trace Elements, R. O. Clark, chairman, is studying flame photometric and spectrographic methods for the determination of small amounts of metals in residual fuels.

Section F on Determination of Tetraethyl lead, J. B. Rather, Jr., chairman, has developed a proposed polarographic procedure for tetraethyl lead in gasoline, which may eventually supplement Method D 526, Test for Tetraethyl lead in Gasoline. More rapid methods for tetraethyl lead will be considered.

Section G on Determination of Carbon, Hydrogen, Nitrogen, and Oxygen, R. Matteson, chairman, applied Method D 1018, Test for Hydrogen in Petroleum Fractions by the Lamp Method, to the determination of hydrogen in petroleum waxes. The error introduced in applying D 1018 to testing stocks containing chlorine and sulfur will be studied.

Research Division IV on Hydrocarbon Analysis, S. S. Kurtz, Jr., chairman, conducted an investigation in cooperation with Committee D-16 on Industrial Aromatic Hydrocarbons, with respect to bromine index of petroleum source aromatics. Benzene and other aromatics for use as chemical raw materials should contain little olefin; therefore, the bromine index should be low.

A proposed method of test for hydrocarbon types in jet propulsion fuels, fluorescent indicator adsorption method, is being published as information. This method will be studied for its applicability to the determination of aromatics in the 400 F plus fraction of jet fuels.

A cooperative test program is under way to evaluate a silver mercuric nitrate method for olefins in gas samples.

Tentative methods for the precise determination of density (D 1217) and refractive index (D 1218) of knock test reference fuels—*iso*-octane, *n*-heptane—were approved. Work is in progress on the measurement of refractive index of hydrocarbons at 80 to 100 C. A method for determination of cracked C-4 hydrocarbons by infrared spectrophotometry will be studied.

Research Division V on Analysis of Fuels, C. A. Neusbaum, chairman, completed studies to support the expansion of Method D 381, Test for Existent Gum in Gasoline (Air-Jet Evaporation Method), to cover the testing of aircraft, turbine, and jet engine fuels. Further development of the method to cover the testing of diesel fuels is planned.

Research Division VI on Analysis of Lubricants, H. P. Ferguson, chairman, conducted cooperative tests on Method D 94, Test for Saponification Number of Petroleum Products by Color-Indicator Titration, in order to check the merits of paraxylenol blue as an indicator and the effect of saponification time.

A thin-film technique for dark-colored oils using Method D 974, Test for Neutralization Value (Acid and Base Numbers), was studied.

Cooperative tests were run on new lubricating oils to compare mixtures of cyclohexane and heptane with ASTM precipitation naphtha. The work will determine whether more uniform precipitation can be obtained from the naphtha used.

Progress was made on revisions of the methods for carbon residue of petroleum products—D 189 (Conradson Carbon Residue), and D 524 (Ramsbottom Coking Method). Information on the interrelation between the two methods has been developed. Further work will be done on the correlation between the methods on stocks of 6 per cent and higher carbon residue values.

Work is planned to improve the precision of the precipitation test (D 91) on all new oils, including the use, if necessary, of a filter technique.

A special group in Section A, Newtonian Liquids, of *Research Division VII on Flow Properties*, J. C. Geniesse, chairman, is preparing a report outlining the steps necessary to bring ASTM tables, charts, and viscosity methods in line with a new value for the absolute viscosity of water, which is to be adopted by the National Bureau of Standards on July 1, 1953.

A pumpability test for residual fuels is being developed which is designed to provide a better index of pumpability than Method D 97, Test for Cloud and Pour Points. Method D 445, Test for Kinematic Viscosity, was completely revised.

Research Division VIII on Volatility, G. G. Lamb, chairman, proposed revisions to ASTM distillation methods D 86, D 158, D 216, D 1160, and ASTM flash point methods D 56, D 92, and D 93. Studies are under way on distillation procedures which will give more satisfactory recoveries for products of high vapor pressure, or for distillations at high altitudes, or both. Work is continuing on the consolidation of distillation methods D 86, D 158, and D 216 into a single write-up.

Efforts to develop a method using null-point head and manometer as a substitute for Bourdon type gages prescribed in Method D 323, Test for Vapor Pressure of Petroleum Products (Reid Method), are continuing.

Additional reduced-pressure distillation data have been supplied for the American Petroleum Institute Project on Vapor Pressure-Temperature Relationships, being conducted at Northwestern Technological Inst.

A study has been initiated to determine whether increased precision can be achieved by substituting a vacuum jacketed column and mantle type heater for equipment now specified in Method D 1160, Test for Reduced Pressure Distillation of Petroleum Products.

Research Division IX on Color, H. M. Hancock, chairman, is considering refinements and improvements in Method D 156, Test for Color of Refined Petroleum Oil by Means of Saybolt Chromometer.

New glass color standards are being developed for the Union Colorimeter by Research Division IX, Hellige, Inc., and the National Bureau of Standards. The new color scale features uniform differences between color standards, and spectrometric units for specifying color.

Research Division X on Corrosion Tests, F. D. Tuemmler, chairman, is studying a test bomb suitable for making corrosion tests of aviation gasolines and other products. Section B on Humidity Cabinets, H. L. Leland, chairman, is developing a humidity cabinet test.

Research Division XI on Calorimetry, A. J. Kraemer, chairman, has been organized within the past year, with the following scope: "The promotion of knowledge of calorimetry in its application to the technology of petroleum, petroleum products, and fuels, and the development, standardization, promulgation, and improvement of apparatus and methods for calorimetric measurements."

A questionnaire was sent to laboratories engaged in oxygen-bomb determinations of the calorific value of liquid and solid fuels, requesting descriptions of equipment and procedures used in carrying out the determinations.

A study panel was appointed to make recommendations regarding the formation of a section on indirect methods for estimating calorific values of liquid fuels. The precision of the current oxygen bomb methods will be evaluated by cooperative test program.

Research Division XII on Graphite Tests, Gus Kaufman, chairman, continued its activities on nomenclature, analysis, abrasion testing, particle size determination, and sampling. As a result of cooperative programs, considerable progress has been made on analysis, abrasion testing, and particle size. Extensive discussions have been held on definitions and on sampling techniques.

The design of an abrasion tester will be completed and cooperative work done within the next several months. A proposed method on particle size is to be revised for use in further cooperative testing. A sampling procedure will be written for consideration. A proposed method for chemical analysis of graphite will be prepared as a basis for further activity.

Subcommittee I on Pharmaceutical Tests, C. F. W. Gebelein, chairman, is developing a standard suitable for calibrating the grease penetrometer used in Method D 937, Test for Penetration of Petrolatum. Currently, the life of the standard (amber petrolatum) is being studied. Color standards for USP white and yellow grade petrolatums are planned.

Subcommittee XVII on Plant Spray Oil Tests, L. Mittelman, chairman, proposed revisions of Method D 483, Test for Unsulfonated Residue of Plant Spray Oils, and Method D 447, Test for Distillation of Plant Spray Oils.

Subcommittee XXIV on Petroleum Sulfonates, C. F. W. Gebelein, chairman, developed a method for analyzing calcium and barium petroleum sulfonates (D 1216–52 T); also Method D 855, Analysis of Petroleum Sulfonates, was revised. Further work on both methods is planned.

The Special Subcommittee on Extreme-Pressure Properties Measurement, Harry Levin, chairman, has been evaluating the Timken test machine for determining the extreme pressure properties of lubricating oils and greases.

Observations based on the results of a cooperative testing program, involving the testing of twelve lubricating oils of varying extreme pressure levels in the Timken machine, were published in the April, 1952, ASTM Bulletin.

The subcommittee has investigated the possibility of standardizing the Timken machine by use of liquid standards of mineral oils containing the extreme pressure additive agents methyldichlorostearate and hexachloroethane.

Results obtained in a cooperative test program with greases of low, medium, and high extreme-pressure ratings, indicate that the Timken machine rates the extreme-pressure quality of a grease with precision equivalent to that for an oil. Work on improving the test will continue. Conclusions and results from the work on liquid standards and lubricating greases will be published in the ASTM Bulletin, supplementing the April, 1952, publication.

The Coordinating Division on Nomenclature, S. S. Kurtz, Jr., chairman, proposed revisions to Standard D 288, Definitions of Terms Relating to Petroleum. Editorial revisions of the definitions for Petroleum Naphtha and Stoddard Solvent will be considered.

The Coordinating Division on Test Methods, F. D. Tuemmler, chairman, is studying recommended practices for applying precision data given in ASTM methods of test for petroleum products and lubricants. The Division hopes to recommend the practices as Tentative next year.

The Coordinating Division on Research, H. P. Ferguson, chairman, prepared statements on three research projects which have been submitted to The Administrative Committee on Research:

1. Precipitation of Insoluble Sediment from Furnace Oils Containing Catalytically Cracked Gas Oils.
2. Effect of Gasoline Composition on Weathering Losses.
3. Storage Stability of Oils Containing Pour Point Depressants Under Fluctuating Temperature Conditions.

The Division anticipates that statements on other research projects will be prepared.

An important feature of the work of ASTM Committee D-2 not emphasized in this article is the close cooperation which has been established between Committee D-2 and the Standardization Committee of the Institute of Petroleum (United Kingdom) with the object of promoting international standards and test methods for petroleum and its products.

Mr. Harry Hyams, Vice-President of the Institute of Petroleum, was present during the 50th Annual ASTM meeting in June and took an active part in the meetings of Committee D-2. Mr. Hyams, a gifted speaker, addressed the Advisory Committee of Committee D-2 and Committee D-2 proper.

The members of Committee D-2 were gratified to learn of the degree of progress made toward agreement between ASTM and IP test methods, and left Mr. Hyams with the wish that work toward this end should continue to the betterment of the two societies.

More Unsolved Problems

Series of Research Problems from ASTM Committees

STATEMENTS of research problems submitted by the technical committees of the Society have been collected in a pamphlet, "Some Unsolved Problems" which may be obtained upon request to ASTM Headquarters, 1916 Race St., Philadelphia, Pa.

These problems have been presented in series in the BULLETIN issues of 1952. The three presented below are the last of these reprints from the pamphlet.

Chemistry and Utilization of Hemicelluloses

Statement of Unsolved Problem Contributed by Committee D-7 on Wood

Problem:

To learn more about the chemistry of hemicelluloses and to find uses for the large quantities of hemicellulose residues of pulp mills that are wasted or used as an inefficient fuel.

Present Status of Knowledge:

Information on the chemistry of hemicelluloses and the sugar decomposition products resulting from pulping operations is very limited. It is known that hemicelluloses can be broken down to sugars and part of them converted to furfural and that they can be used for growing yeast and chemical-producing organisms. Some of the dextrin-like products show adhesive properties.

Questions That Need to Be Answered:

More information on the nature and chemical reactions of the hemicelluloses is needed as an aid in developing better and more extensive means of utilizing these stream-polluting chemicals.

Introductory References:

(1) "Derived Products and Chemical Utilization of Wood Waste," *Report R1666-10*, U. S. Forest Products Laboratory, Madison, Wis.

(2) L. E. Wise, "Wood Chemistry," Reinhold Publishing Co., New York, N. Y. (1944).

Additional information may be obtained from L. J. Markwardt, U. S. Forest Products Laboratory, Madison 5, Wis.

Dimensional Stabilization of Wood

Statement of Unsolved Problem Contributed by Committee D-7 on Wood

Problem:

To find new, more effective, and more easily applied means of stabilizing the across-the-grain dimensions of wood as influenced by moisture changes.

Present Status of Knowledge:

Three principles have been developed by which the across-the-grain dimensional stabilization of wood can be accomplished: namely, (1) chemically replacing hydroxyl groups with less polar groups; (2) bulking the fiber; and (3) creating chemical cross bridges between the structural units. The best methods to date, namely, forming resins within the cell-wall structure and acetylation, fall into the second class. Class (2) methods, however, use more chemical than is desired and resin treatment embrittles the wood. Theoretically, method (3) appears the most promising. This method has thus far been accomplished only by reacting the wood with formaldehyde vapor. This reaction, however, requires a pH of about 1 to take place. This acidity alone badly embrittles wood.

Questions That Need to Be Answered:

Cross-linking agents should be sought that react with hydroxyl groups in a practically neutral medium.

Introductory References:

(1) A. J. Stamm, "Modified Woods," Modern Plastics Encyclopedia, p. 725 (1948).

(2) A. J. Stamm and E. E. Harris, "Chemical Processing of Wood," Chemical Publishing Co., Brooklyn, N. Y.

Additional information may be obtained from L. J. Markwardt, U. S. Forest Products Laboratory, Madison 5, Wis.

Evaluation of Construction Materials Comprising Bituminous Products in Combination with Nonbituminous Components

Statement of Unsolved Problem Contributed by Committee D-8 on Bituminous Waterproofing and Roofing Materials

Problem:

Recent practice has led to construction use of new or of untried nonbituminous materials in combination with bituminous compositions, both cold and hot applied. Frequently doubt is raised as to the service performance of such specific combinations even though the separate ingredients comprising the installation may be considered serviceable from experience in other combinations or different installations.

Present State of Knowledge:

Apart from a certain few very well-established combinations, the quality of which has been established by many long years of service life, there are little or no available knowledge and significant test methods to evaluate properly combinations of two or more new materials or of established products hitherto not jointly used.

Questions That Need to Be Answered:

1. How best to evaluate combined materials in service form under accelerated and under service conditions, as distinguished from the present practice of studying, testing, and specifying the appropriate properties for the individual components of the system.
2. How to determine which of the many new types of nonbituminous new materials are best suited for specific uses in combination with standard bitumous products and construction methods.

Additional information may be obtained from H. R. Snoke, Nat. Bureau of Standards, 4707 Industrial Bldg., Washington 25, D. C.

Proposed Tentative Method of Test for Compressive Strength of Hydraulic-Cement Mortars Using Portions of Prisms Broken in Flexure

EDITOR'S NOTE.—This proposed method has been prepared by Working Committee on Strength of ASTM Committee C-1 on Cement, under the chairmanship of C. E. Wuerpel, Marquette Cement Mfg. Co. This method is being published as information only in order to solicit comments preliminary to further consideration for adoption by the Society. Comments should be addressed to the Society, 1916 Race St., Philadelphia, Pa.

Scope:

1. This method of test is intended for determining the compressive strength of hydraulic-cement mortars using for the test specimens portions of prisms broken in flexure.

NOTE.—For the method of making the flexural strength test, see the Proposed Tentative Method of Test for Flexural Strength of Hydraulic-Cement Mortars, above.

Apparatus:

2. (*a*) *Bearing Plates.*—The two bearing plates shall not be less than 1 in. in thickness and shall be made of hard metal. The surfaces of the bearing plates that are placed in contact with the specimen shall be 2 ± 0.01 in. on the two sides that are placed parallel with the length of the specimen and not less than 2 in. nor more than 2.05 in. on the two sides that are placed at right angles with the length of the specimen. The bearing plate surfaces intended for contact with the specimen shall have a Rockwell hardness number not less than C 60. These surfaces shall not depart from plane surfaces by more than 0.0005 in. when the plates are new and shall be maintained within a permissible variation of 0.001 in.

(*b*) *Device for Aligning Bearing Plates.*—A device for aligning the bearing plates to insure the proper location of the upper plate with reference to the lower plate is shown in Fig. 1.

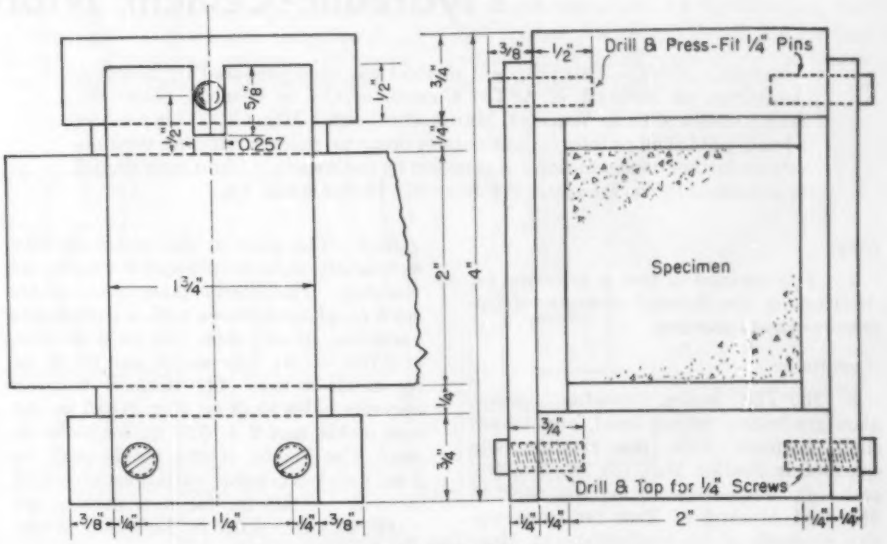
(*c*) *Testing Machine.*—The testing machine shall conform with the requirements prescribed in Section 2(*k*) of ASTM Standard Method of Test for Compressive Strength of Hydraulic-Cement Mortars (C 109).[1]

Test Specimens:

3. Two portions from each prism broken in flexure shall be used for compression testing except that the broken portions of prisms selected for the compression test shall have a length of not less than 3 in. and shall be free from cracks, chipped surfaces, or other obvious defects.

Procedure:

4. During the interval between flexural tests of the prisms and testing the broken portions as modified 2-in. cubes, the specimens shall be kept in a pan of water at a temperature of 23 ± 1.7 C (73.4 ± 3 F) and of sufficient depth to completely immerse each specimen until time of testing. The specimen shall be wiped to a surface-dry condition, and any loose sand grains or incrustations shall be removed from the faces that will be in contact with the bearing blocks of the testing machine. These faces shall be checked by application of a straightedge (Note 1). If appreciable curvature is present, the face or faces shall be ground to plane surfaces or the specimen shall be discarded. The test specimen shall be turned on its side with respect to its position as molded and placed in the device for aligning the bearing plates. The upper bearing plate shall be put in place and the load shall be applied in the manner prescribed in Section 12(*c*) of ASTM Standard Method of Test for Compressive Strength of Hydraulic-Cement Mortars (C 109).[1]



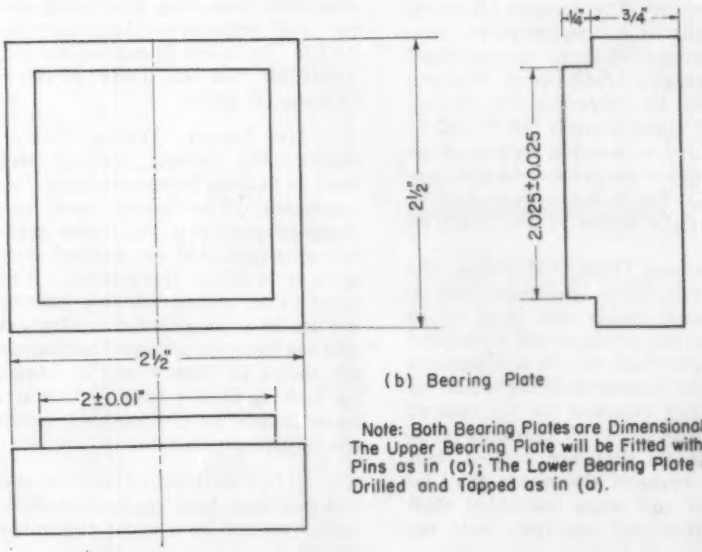


Fig. 1.—Bearing Plate and Bearing Plate Aligning Device.

[1] 1950 Supplement to 1949 Book of ASTM Standards, Part 3, p. 26.

Calculation:

5. The total maximum load indicated by the testing machine shall be recorded and the compressive strength calculated in pounds per square inch.

Faulty Specimens and Retests:

6. Specimens that are manifestly faulty, or that give strengths differing more than 10 per cent from the average value of all test specimens made from the same sample and tested at the same period, shall not be considered in determining the compressive strength. After discarding strength values, if less than two strength values are left for determining the compressive strength at any given period, a retest shall be made (Note 2).

NOTE 1. *Modified Cube Faces.* Results much lower than the true strength will be obtained by loading faces of the modified cube which are not truly plane surfaces. Therefore, it is essential that molds be kept scrupulously clean, as otherwise large irregularities in the surfaces will occur. Instruments for cleaning of molds should always be softer than the metal in the molds to prevent wear. In case grinding of modified cube faces is necessary, it can be accomplished best by rubbing the specimen on a sheet of fine emery paper or cloth glued to a plane surface, using only a moderate pressure. Such grinding is tedious for more than a few thousandths of an inch; where more than this is found necessary, it is recommended that the specimen be discarded.

NOTE 2.—Reliable strength results depend upon careful observance of all of the specified requirements and procedures. Erratic results at a given test period indicate that some of the requirements and procedures have not been carefully observed; for example, those covering the testing of the modified cubes as prescribed in Sections 3 and 4. Improper centering of specimens resulting in oblique fractures or lateral movement of one of the heads of the testing machine during loading will often cause lower strength results. A specimen so broken shall be considered as "manifestly faulty" if its strength differs by more than 10 per cent from the average of all test specimens made from the same sample and tested at the same period.

Proposed Method of Test for Flexural Strength of Hydraulic-Cement Mortars

EDITOR'S NOTE.—This proposed method has been prepared by Working Committee on Strength of ASTM Committee C-1 on Cement, under the chairmanship of C. E. Wuerpel, Marquette Cement Mfg. Co. This method is being published as information only in order to solicit comment preliminary to further consideration for adoption by the Society. Comments should be addressed to the Society, 1916 Race St., Philadelphia, Pa.

Scope:

1. This method of test is intended for determining the flexural strength of hydraulic-cement mortars.

Apparatus:

2. (*a*) The scales, weights, sieves, glass graduates, mixing bowl, and trowel shall conform with the requirements specified in Section 2(*a*), (*b*), (*c*), (*d*), (*f*), and (*j*), respectively, in the ASTM Standard Method of Test for Compressive Strength of Hydraulic-Cement Mortars (C 109).[1]

(*b*) *Tamper.*—The tamper (Note 1) shall be made of a nonabsorptive, nonabrasive material such as medium-hard rubber or seasoned oak wood rendered nonabsorptive by immersion for 15 min in paraffin at approximately 200 C (392 F) and shall have a tamping face of 1 in. by 4½ in., and a convenient length (approx. 3 in.). The tamping face shall be flat and at right angles to the length of the tamper.

(*c*) *Specimen Molds.*—Molds for the 2 by 2 by 12-in. prism specimens shall be single specimen molds and shall be so designed that the specimen will be molded with its longitudinal axis in a horizontal position. The molds shall be made of hard metal not attacked by the cement mortar and the Rockwell hardness number of the metal shall not be less than B 55. The parts of the molds shall be matchmarked and when assembled shall be tight fitting and positively held together. The sides of the molds shall be sufficiently rigid to prevent spreading or warping. The interior faces of the molds shall be plane surfaces with a permissible variation, in any 2-in. line on a surface, of 0.001 in. for new molds and 0.002 in. for molds in use. The distance between opposite sides shall be 2 ± 0.015 in. for new molds, and 2 ± 0.02 in. for molds in use. The height of the molds shall be 2 in. with permissible variations of +0.01 in. and −0.005 in. for new molds, and +0.01 in. and −0.015 in. for molds in use.

(*d*) *Flow Table.*—The flow table, flow table mounting, flow mold, and caliper shall conform to the requirements in ASTM Tentative Specifications for Flow Table for Use in Tests of Hydraulic Cement (C 230).[2]

(*e*) *Flexure Testing Device.*—The center-point loading method shall be used in making flexure tests on the prism specimens. The device used shall be designed such that the forces applied to the specimen will be vertical only and applied without eccentricity. Two devices which accomplish this purpose, one for use in a compression testing machine and one for use in a briquet testing machine are shown in Figs. 1 and 2. Apparatus for making flexure tests of mortar specimens should be designed to incorporate the following principles:

(*1*) The distance between supports and points of load application should remain constant for a given apparatus.

(*2*) The load should be applied normal to the loaded surface of the specimen and in such a manner as to avoid eccentricity or loading.

(*3*) The direction of the reactions should be parallel to the direction of the applied load at all times during the test.

(*4*) The load should be applied at a uniform rate and in such a manner as to avoid shock.

(*f*) *Compression Testing Machine.*—The compression testing machine used with the flexure-testing device shall be of the hydraulic type with sufficient opening between the upper bearing surface and the lower bearing surface of the machine to permit the use of verifying apparatus. The load applied to the test specimen shall be at the rate of 600 ± 24 lb per min, and it shall be indicated with an accuracy of ±1 per cent on a dial readable in increments of 10 lb.

(*g*) *Briquet Testing Machine.*—The briquet testing machine used with the flexure-testing device shall conform with the requirements prescribed in Section 2(*g*) in ASTM Standard Method of Test for Tensile Strength of Hydraulic-Cement Mortars (C 109).[1]

Graded Standard Sand:

3. The sand used for making test specimens shall be natural silica sand (Note 2) from Ottawa, Ill., graded as specified in ASTM Standard Method of Test for Compressive Strength of Hydraulic-Cement Mortars (C 109).[1]

Sieve Analysis of Sand:

4. A sieving test of the sand shall be made as prescribed in Section 5(*a*) and (*b*) in ASTM Standard Method of Test for Compressive Strength of Hydraulic-Cement Mortars (C 109).[1]

[1] 1950 Supplement to 1949 Book of ASTM Standards, Part 3, p. 26.

[2] 1949 Book of ASTM Standards, Part 3, p. 25.

Number of Specimens:

5. Two or more prism specimens shall be made for each period of test specified.

Preparing Specimen Molds:

6. The contact surfaces of the parts of the molds shall be thinly covered with a heavy mineral oil or light cup grease such as petrolatum. The interior faces of the specimen molds shall be thinly covered with mineral oil or light cup grease. After assembling the molds, excess oil or grease shall be removed from the interior faces and the top and bottom surfaces of each mold. Molds shall then be set on plane, nonabsorptive base plates which have been thinly coated with mineral oil, petrolatum, or light cup grease. A mixture of 3 parts of paraffin to 5 parts of rosin by weight, heated between 110 and 120 C (230 and 248 F), shall be applied at the outside contact lines of the molds and base plates so that watertight joints are effected between the molds and the base plates (Note 3).

NOTE.—Improved bond and watertightness between mold and baseplate may be obtained by keeping the bottom of the mold and the baseplate free of oil or grease until after bonding with the paraffin-rosin mixture, but care must be used in oiling the baseplate thereafter to avoid any excess in the corners or the angles between sides of mold and baseplate.

Proportioning, Consistency, and Mixing of Mortar:

7. The proportioning, consistency, and mixing of the standard mortar shall be the same as specified in Sections 8 (*a*) and (*b*) in the ASTM Standard Method of Test for Compressive Strength of Hydraulic Cement Mortars (C 109). The quantities of dry materials to be mixed at one time in the batch of mortar for making one prism specimen shall be 500 g of cement and 1375 g of graded standard sand.

8. The flow shall be determined as prescribed in Section 9 of ASTM Standard Method of Test for Compressive Strength of Hydraulic-Cement Mortars (C 109).[1]

Molding Test Specimens:

9. Immediately following completion of the flow test, the mortar from the flow mold shall be returned to the mixing bowl and the entire batch shall be given a 15-sec mixing with one hand protected with a rubber glove, after which the glove shall be freed of adhering mortar. Within a total elapsed time of not more than 2 min and 15 sec after completion of the original mixing of the mortar batch, molding of the prism specimen shall be started. With the mold set parallel to the front edge of the work bench, a layer of mortar about 1 in. in thickness shall be placed in the mold and uniformly distributed. This layer shall be tamped by a total of 18 strokes of the tamper in the following manner: with the tamper held in a vertical position and close to the far side of the mold, apply pressure first to one corner, then to the center, and then to the other corner. Repeat on the near side of the mold. Repeat this whole operation for a total of three times. The tamping pressure shall be just sufficient to squeeze out some mortar from under the tamper blade. The mold shall then be filled with mortar, which shall be uniformly distributed and tamped in the same manner as the bottom layer. On completion of the tamping, the mortar should extend slightly above the top surface of the mold. The mortar which has been forced out onto the top of the mold shall be brought in with a trowel and the specimen smoothed off by drawing the flat side of the trowel (with the leading edge slightly raised) once along the length of the mold. The mortar shall then be

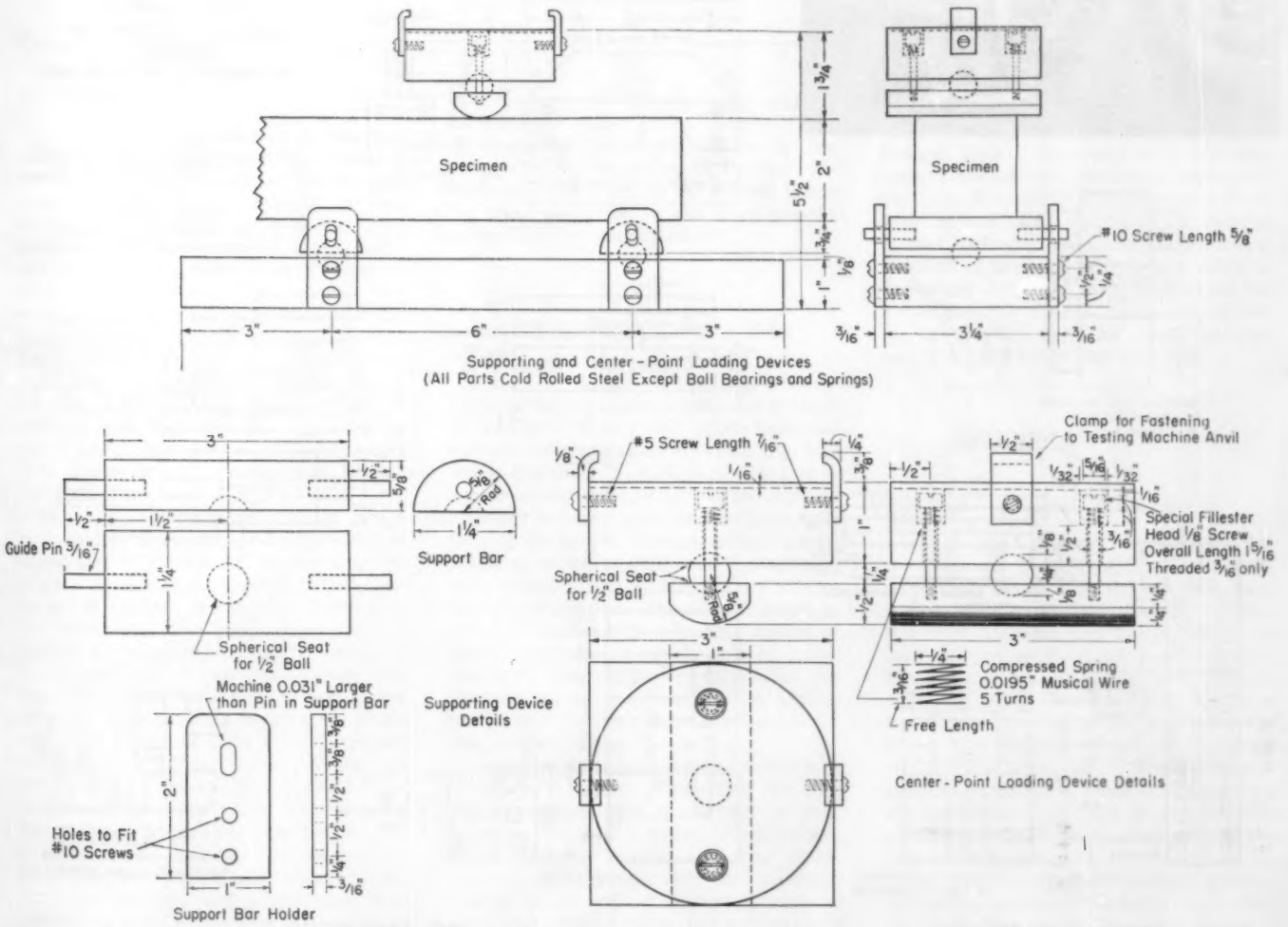


Fig. 1.—Center-Point Supporting and Loading Devices for Testing 2 by 2-in. Mortar Prisms in Flexure in a Compression Testing Machine.

cut off to a plane surface flush with the top of the mold by drawing the straightedge of the trowel (held nearly perpendicular to the mold) with a sawing motion over the length of the mold.

Storage of Test Specimens:

10. The test specimens shall be stored in the manner specified in ASTM Standard Method of Test for Compressive Strength of Hydraulic-Cement Mortars (C 109).[1]

Procedure:

11. (*a*) Testing of the prism specimens shall be carried out immediately after their removal from the moist closet for 24-hr specimens, and from storage water for all other specimens. If more than one specimen at a time is removed from the moist closet for the 24-hr tests, these prisms shall be covered with a damp cloth until time of testing. If more than one specimen at a time is removed from the storage water for testing, these prisms

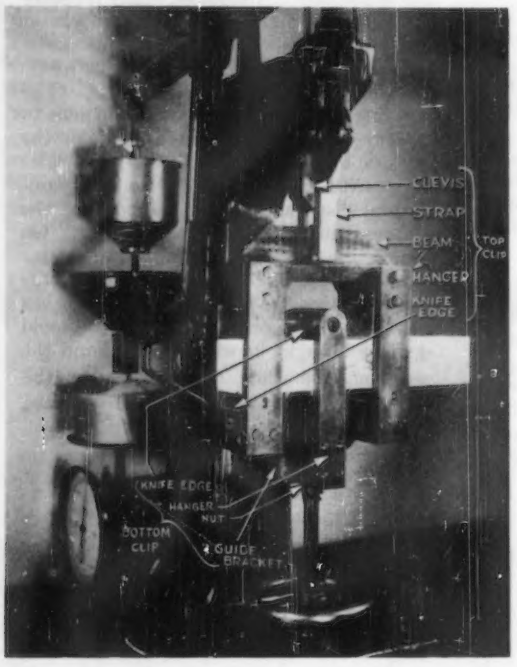


Fig. 2.—Flexure Testing Device for Use with Briquet Testing Machine.

shall be placed in a pan of water at a temperature of 23 ± 1.7 C (73.4 ± 3 F) and of sufficient depth to completely immerse each prism until time of testing.

(*b*) Each prism shall be wiped to a surface-dry condition, and any loose sand grains or incrustations shall be removed from the faces that will be in contact with the bearing surfaces at the points of support and load application. These faces shall be checked by application of a straightedge. If appreciable curvature is present, the face or faces shall be ground to plane surfaces or the specimen shall be discarded.

(*c*) The test specimen shall be turned on its side with respect to its position as molded and placed on the supports of the testing device. No cushioning or bedding materials shall be used. The specimen shall then be loaded at the center point of a 6-in. span. Two tests shall be made on each specimen.

Calculation:

12. The total maximum load indicated by the testing machine shall be recorded and the flexural strength (for the particular size of specimen and conditions of test herein described) calculated in pounds per square inch as follows:

$$S = 1.125P$$

where:

S = flexural strength, psi, and
P = maximum applied load indicated by the testing machine, lb.

Faulty Prisms and Retests:

13. Prisms that are manifestly faulty, or that give strengths differing by more than 10 per cent from the average value of all test specimens made from the same sample and tested at the same period, shall not be considered in determining the flexural strength. After discarding prisms or strength values, if less than two strength values are left for determining the flexural strength at any given period, a retest shall be made.

NOTE 1.—Use of the above-described tamper was taken from the German cement specification DIN 1164 where such prism specimens as are specified herein are used. It is believed that the larger tamper will provide results superior to those which would be obtained by the small tamper specified in standard Method C 109 for preparing 2-in. cube specimens.

NOTE 2. *Segregation of Graded Sand.*—The graded standard sand should be handled in such a manner as to prevent segregation, since variations in the grading of the sand cause variations in the consistency of the mortar. In emptying sacks of sand into bins or in scooping sand out of bins or sacks, care should be exercised to prevent the formation of mounds of sand or craters in the sand, down the slopes of which the coarser particles will roll. Bins should be of sufficient size to permit these precautions. Devices for drawing the sand from bins by gravity should not be used.

NOTE 3. *Watertight Molds.*—The mixture of paraffin and rosin specified for sealing the joints between molds and base plates may be found difficult to remove when molds are being cleaned. Use of straight paraffin is permissible if a watertight joint is secured, but due to the low strength of paraffin it should be used only when the mold is not held to the base plate by the paraffin alone. A watertight joint may be secured with paraffin alone by slightly warming the mold and base plate before brushing the joint. Molds so treated should be allowed to return to the specified temperature before use.

Research at NBS

NBS Stiffness Tester

A SENSITIVE instrument which rapidly and conveniently measures the stiffness of commercial papers has been developed at the National Bureau of Standards. In the new device, the specimen is bent through a given angle and its stiffness measured by the torque in a wire suspension. By varying the width and length of the specimen and the angle through which it is bent, and by using supporting wires of different sizes, instruments of this type could be employed to test papers having a wide range of stiffness and they are also expected to prove useful in evaluating the stiffness of thin plastic sheet, textiles, and similar materials.

The NBS device is designed to put a measured twist on the specimen, which is supported in clamps at its two vertical edges. One clamp, through which the torque is applied, is securely attached to the specimen; the other clamp, which applies the reaction, holds the specimen loosely so that it can bend freely and naturally. The first clamp is suspended between two vertical lengths of piano wire, and the outer ends of the wires are fastened to a torque frame. When the torque frame is rotated, the applied torque is transmitted by the piano wires to bend the paper. A pointer attached to the rotating clamp indicates (by its position on a fixed scale) the angle through which the paper is bent, and at the same time shows (on a scale attached to the torque frame) the torque applied to the piano wire.

The apparatus owes its sensitivity in considerable degree to a design which eliminates the need of bearings in the torque measuring device. Another advantage of the design is the vertical bending axis, which makes the measurement independent of gravity effects.

Isotopic Method of Determining Water Content

A METHOD which uses heavy water to determine the total water content of biological tissues and other materials has recently been developed at the National Bureau of Standards. Based on a spectroscopic measurement of the ratio of ordinary to heavy water in a solution containing the sample, the new method is outstanding in the rapidity and convenience with which it can be applied to a large number of samples. Other applications in which it has been used include studies of water exchange in resins and of water transport through human capillaries, determination of moisture in the atmosphere, and the identification of unknown organic molecules.

Essentially the NBS method consists in dissolving a known amount of the material to be analyzed in a mixture of deuterium oxide (heavy water) and hydrogen oxide (ordinary water) and then determining spectroscopically the resulting change in the ratio of deuterium oxide to hydrogen oxide. From the difference in this ratio before and after addition of the sample, the water content of the sample material, which is assumed to contain no deuterium oxide, is computed.

The analysis takes advantage of the wavelength separation of the emission lines of hydrogen and deuterium due to the isotopic shift. By means of a high-frequency electrodeless discharge, water vapor from the sample is dissociated into H and OH and into D and OD. The ratio of excited hydrogen to deuterium, which is a function of the ratio of hydrogen oxide to deuterium oxide, is then determined by measuring the relative intensities of the H_B line (4860.0 A.). An entire analysis can be carried out in one-half hour.

NBS Study of Crucible Graphite

A RECENT investigation by the National Bureau of Standards indicates that, for making the crucibles used in non-ferrous foundries, domestic graphites from Alabama and Pennsylvania are fully as good as the traditional imported Madagascar graphite. It also appears from this study that small-flake graphite can be used instead of the generally preferred large-flake type without impairing the service life of "carbon-bonded" graphite crucibles. Tests indicated that the carbon-bonded type of crucible has about twice the average service life of the clay-bonded type.

As a result of the NBS findings, a Pennsylvania graphite mine is being reactivated to insure the availability of a domestic supply in the event the lower-cost Madagascar graphite should be cut off.

The Portland Cement Industry

A 51-PAGE monograph entitled "The Portland Cement Industry" by Hubert C. Persons, Manager, Public Relations Bureau, Portland Cement Assn. is the latest in a series of American Industries Monographs, published by Bellman Publishing Co.

This booklet appears in an attractive form, with numerous photographs and illustrations. It presents an easy-to-read treatise on the various elements and phases of the manufacture and use of portland cement. It discusses first a description on what portland cement is and the several common types as defined by ASTM, the many uses, history of the industry, raw materials used in the manufacture of portland cement, and a description of the manufacturing process. The story of the Portland Cement Assn. is given with its purposes and functions. Several paragraphs are given over to personnel in the industry, including the advantages of employment, volume of employment, functional organization, and qualifications of employees.

The author closes with brief reference to the allied industries and products based on the use of portland cement and presents his outlook for future developments in the industry. This publication can be obtained from the Bellman Publishing Co., P. O. Box 172, Cambridge 38, Mass. at a cost of $1 per copy.

Investment Castings for Engineers

INVESTMENT casting is one of the five modern techniques for precision casting of fluid metal and is the modern equivalent of the ancient "lost wax" process.

The authors, Rawson L. Wood and Davidlee Von Ludwig offer in this volume a comprehensive description of the salient features, advantages, and limitations of investment castings and have designed their book for daily reference use.

They have emphasized throughout design engineering factors which determine the attainable precision of cast dimension, cleanliness, and uniformity of metallurgical structure. They point out both present accomplishments and the considerations involved in developing further the industrial phase of investment casting. Present design and metallurgical limits are clearly defined, as are the degrees of cast tolerance control now commercially obtainable. All data are derived from actual test results of investment cast specimens, and various interrelationships between wax, plastic, and mercury processes are fully outlined. Two chapters deal with the frozen mercury method, the entire mechanics of which have never before appeared in print.

Copies of this fully illustrated book can be obtained for $10 from the publisher, Reinhold Publishing Corp., 330 W. 42nd St., New York, N. Y.

New American Standard Practice for Lighting Industrial Plants

A NEW American Standard Practice for Industrial Lighting has recently received full approval of the ASA and is being published in a 40-page booklet by the sponsor, the Illuminating Engineering Society. Completely revising the first recommended practice on this vital lighting problem published ten years ago, the new standard covers many specific lighting problems not included in the 1942 report. Since then studies and reports have covered lighting for woolen and worsted mills; canneries; commercial bakeries; inspection lighting problems such as supplementary lighting and lighting for machining small metal parts, and other industrial lighting tasks.

The new Standard Practice analyzes the facts affecting industrial seeing tasks and the elements of good illumination required to perform those tasks. A wide variety of these tasks within specific manufacturing categories from Airplanes through Woodworking are listed alphabetically in convenient tables giving required footcandles for each. Necessary quantities of illumination; qualities of light sources; distribution and diffusion; brightness ratios and reflectance values of surrounding areas are also explained and recommended. Table VI, Classification of Visual Tasks and Lighting Techniques, lists many general characteristics of industrial tasks and recommends lighting techniques for each.

Copies may be obtained direct from: Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y. Price 50¢.

Papers from International Bridge Building Congress

PUBLISHED by the General Secretariat in Zurich, the "1951 Publications of the International Association for Bridge and Structural Engineering" contains in three languages papers on the general subject of bridge engineering. To mention a few, there are papers on corrugated concrete shell structures, spatial supporting frames, precompressed steelwork, deformations of reinforced concrete. There are 16 papers in all, of which seven are in English, six in French, and three in German. For the papers written in other than the English language, titles and summaries are given in English.

Further information about this publication can be obtained by writing to F. Stussi, Professor at the Swiss Federal Institute of Technology, Zurich.

Of Special Note—

THE following excerpt from Prof. D. M. Burmister's introduction to the Symposium on Consolidation Testing of Soils emphasizes the importance of considering basic testing conditions in evaluating properties of materials. He incorporates this reference to point out that in contrast to somewhat ideal conditions the soils engineer seldom, if ever, finds it possible to apply a generalized standard test approach. Soil samples in each situation may be different in important respects.

"It is within the range of elastic behavior only that the properties of materials are not affected by the conditions imposed in a test, and that tests can be relied upon to yield results which not only have a high degree of consistency and reproducibility but also have well-established, constant, and predictable relations to the actual behavior and performance of the materials under service conditions in structures. This is true in general for the common structural materials because they have uniform, constant, physical properties within the range of common usages and of working stresses below the elastic limit, and because these properties are practically unaffected by the common stress and other conditions to which the materials may be subjected during and subsequent to construction of structures and in service. The principal objectives for testing structural materials for use in structures are to determine the uniformity, quality, and acceptability of such materials manufactured or processed in large quantities to definite specifications. These are the basic concepts involved in the standard test approach and they constitute the principal justification for its use in the case of the common structural materials. Under such conditions standard testing procedures can be straightforward, readily applied statements of techniques for the conduct of a test, which have a general application to all of the common design and construction problems. Such test procedures as a consequence involve practically no elements of uncertainty and require little or no judgment in their application."

Rheotropic Embrittlement*,[1]

By E. J. Ripling[2]

SYNOPSIS

The ductility deficiency exhibited by metals not crystallizing in the face-centered cubic system, when these metals are strained at low temperatures, high strain rates, or in the presence of hydrostatic tension, has recently been shown to be partially strain curable. The portion of this embrittlement which can be overcome by prestrain under some ductile conditions has been labeled "Rheotropic Embrittlement."

Descriptions of several of the variables which influence rheotropic behaviors have been presented in a number of publications. This paper is a correlated abstract of the influence of these variables.

IT IS generally thought that any metal which does not crystallize in the face-centered cubic system will exhibit a rather narrow testing temperature range (the transition temperature) over which it abruptly changes from ductile and tough to brittle. See curve *A* in Fig. 1 (**1, 2**).[3] In a recent series of investigations it has been shown that this ductility (and presumably the toughness) deficiency at subtransition temperatures can be cured, partially at least, by cold working the metal at a supertransition temperature before testing it at the subtransition temperature. This portion of low-temperature brittleness which is strain-curable has been labeled "Rheotropic Brittleness."

Rheotropic effects become apparent when metals which exhibit a transition behavior are first deformed at some supertransition temperature (generally by stretching) prior to testing at some lower temperature. If both the prestraining and testing are by tension, test data of this type are readily analyzed, since the total strain in this case can be considered as the result of a two-step tension test. Furthermore, if in addition to both strains being tensile, the prestrain and testing temperatures are both above the transition temperature, there is a simple relationship between the magnitude of the prestrain and the retained ductility as given by the following equation:

$$\left(\frac{\epsilon_p}{\epsilon_A}\right)^m + \left(\frac{\epsilon_r}{\epsilon_B}\right)^n = 1 \quad \ldots\ldots (1)$$

where:

ϵ_r = retained ductility in second straining (the strain unit used here, ϵ, is defined as the natural logarithm of ratio of the original to final cross-sectional area)

ϵ_A = fracture ductility at the temperature of the first strain,

ϵ_B = fracture ductility at the temperature of the second strain,

ϵ_p = prestrain, and

m and n = arbitrary material constants.

The retained ductility-prestrain curves are generally linear, such as curves *B* and *C* in Fig. 1 so that the exponents m and n are usually both equal to one.

According to Eq 1, the ductility retained in a metal at some low temperature after it had been worked at a higher temperature is proportional to the fracture ductility at both the prestraining and testing temperatures. Hence if a metal were stretched at T_1 and then tested at some lower temperature which was still above the transition temperature, such as T_2 in Fig. 1, the retained ductility would be proportional to the fracture ductility at both T_1 and T_2 (curve *C* in Fig. 1). It is this behavior,

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Fifty-fifth Annual Meeting of the Society, June 23–27, 1952.

[1] This article is based upon research work carried out at Case Institute of Technology in cooperation with the Office of Naval Research, U. S. Navy.

[2] Senior Research Associate, Metals Research Laboratory, Department of Metallurgical Engineering, Case Institute of Technology, Cleveland, Ohio.

[3] The boldface numbers in parentheses refer to the list of references appended to this paper.

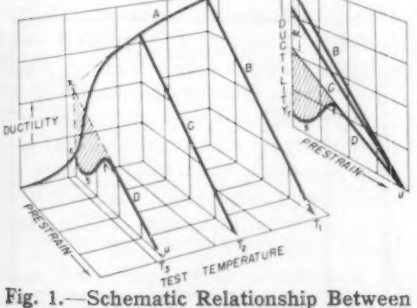


Fig. 1.—Schematic Relationship Between Ductility, Testing Temperature, and Prestrain.

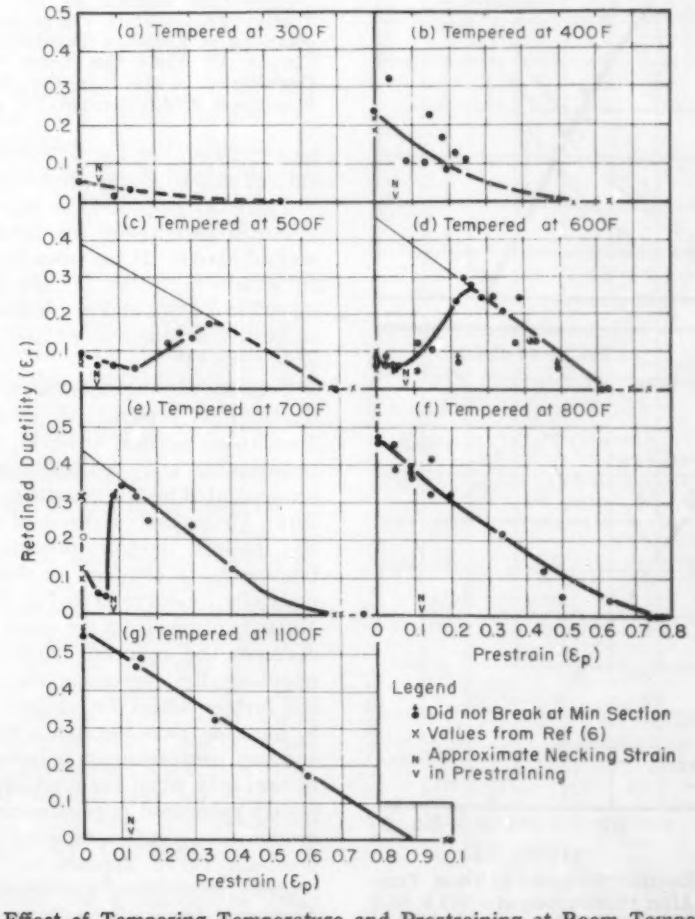


Fig. 2.—Effect of Tempering Temperature and Prestraining at Room Temperature on the Retained Ductility of Martensitic SAE 1340 Steel at −321 F (−196 C) (5).

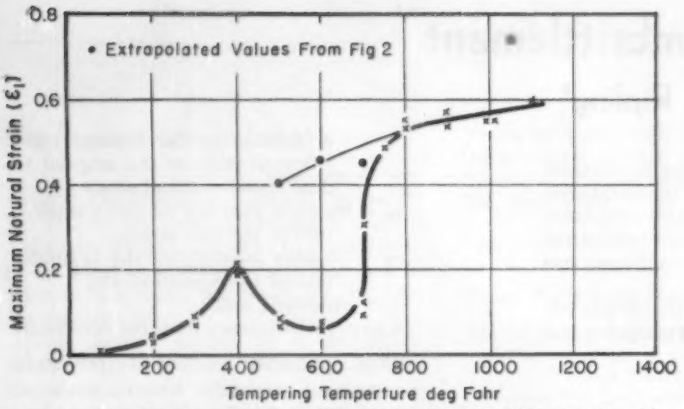
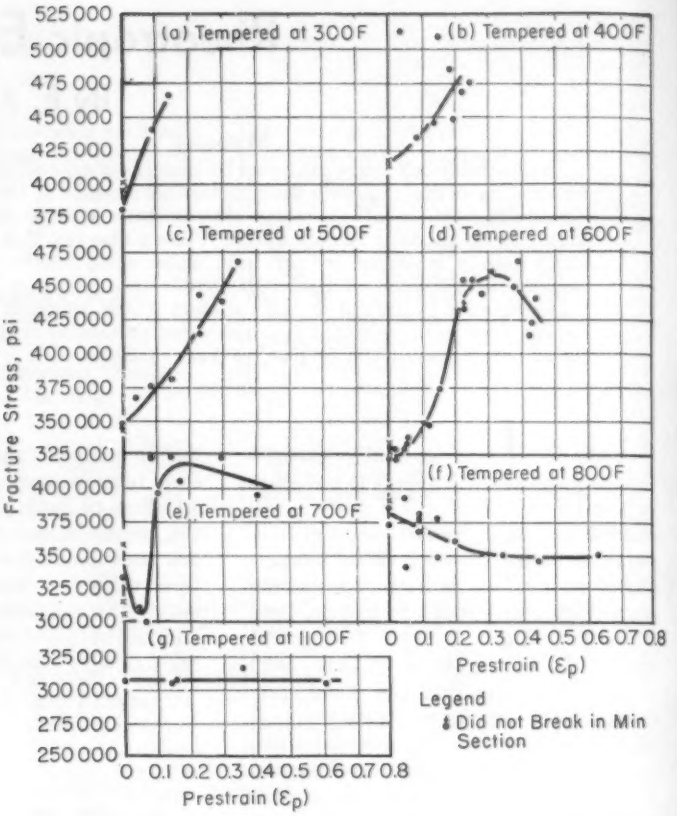


Fig. 3.—Low Temperature Ductility of Martensitic SAE 1340 Steel in the Absence of Disturbing Condition That Causes 600 F Embrittlement (5).

NOTE.—Specimens held at tempering temperature for 1 hr, then water quenched.

Fig. 4.—Effect of Tempering Temperature and Prestraining at Room Temperature on the Fracture Stress of Martensitic SAE 1340 Steel at −321 F (−196 C) (2).



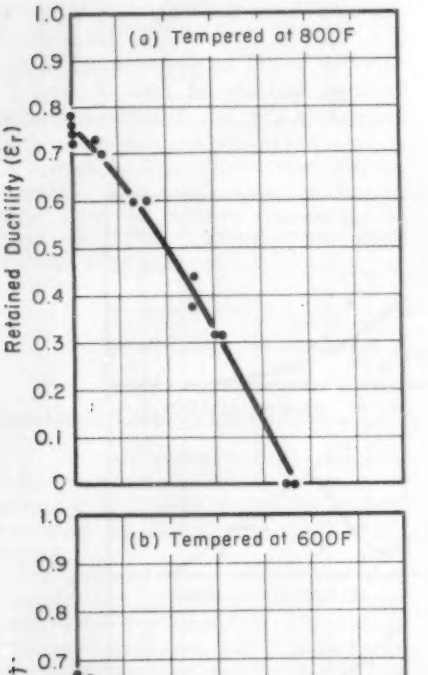


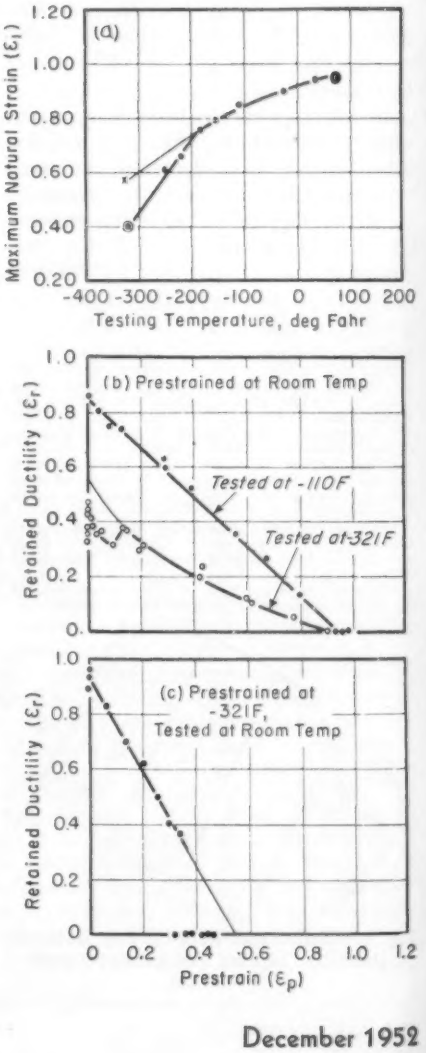
Fig. 5.—Ductility Retained at Room Temperature After Prestraining at −321 F SAE 1340 (Quenched and Tempered at Indicated Temperature (5)).

Fig. 6.—Extrapolations of Supertransition Temperature Branch of the Ductility-Testing Temperature Curve and Extrapolations of Retained Ductility-Prestrain Curves All Yield the Same Value for Ductility at −321 F in the Absence of Rheotropic Embrittlement (5).

as described by Eq 1 which is considered as the normal effect of strain.

There is considerable experimental evidence to support the behavior described above. It has been found in an annealed silicon steel (3), the aluminum alloy 24S-T4 (4), and in a low-alloy steel in both the heat-treated and annealed conditions (5).

This simple dependence of retained ductility on prestrain as given by Eq 1 no longer applies, however, when the prestraining and testing temperatures are separated by the transition temperature. Under this condition of straining, the retained ductility-prestrain curves become quite complex as shown schematically by curve *D* in Fig. 1. Small amounts of prestrain are again found to decrease the retained ductility; but, paradoxically, increasing the prestrain still further causes the retained ductility to increase, pass through a maximum, and then decrease again to become equal to zero only when the ductility is completely exhausted in prestraining. This second more complex retained ductility-prestrain curve appears to be compounded from two of the simpler curves discussed above. Branches *r-s* and *t-u* of curve *D* are somewhat similar to the



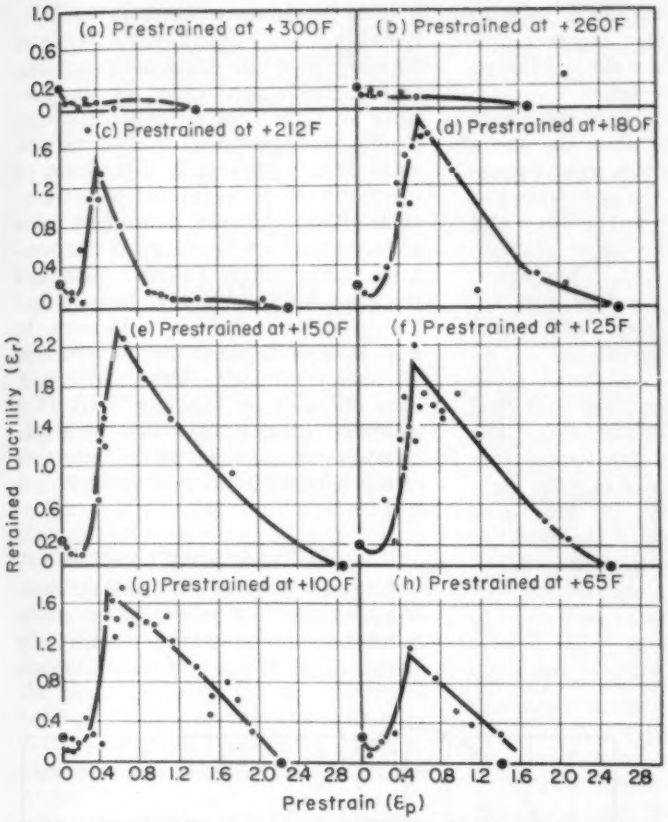


Fig. 7.—Effect of Prestraining a Commercially Pure Zinc at the Temperatures Shown on the Ductility at +32 F (7).

Prestraining and testing both at a strain rate of 0.05 in. per min.

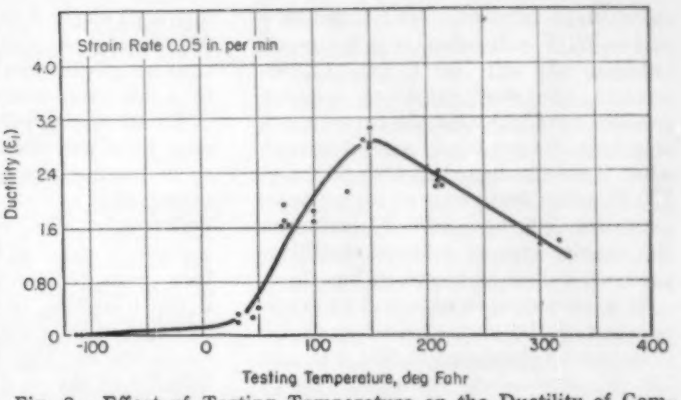
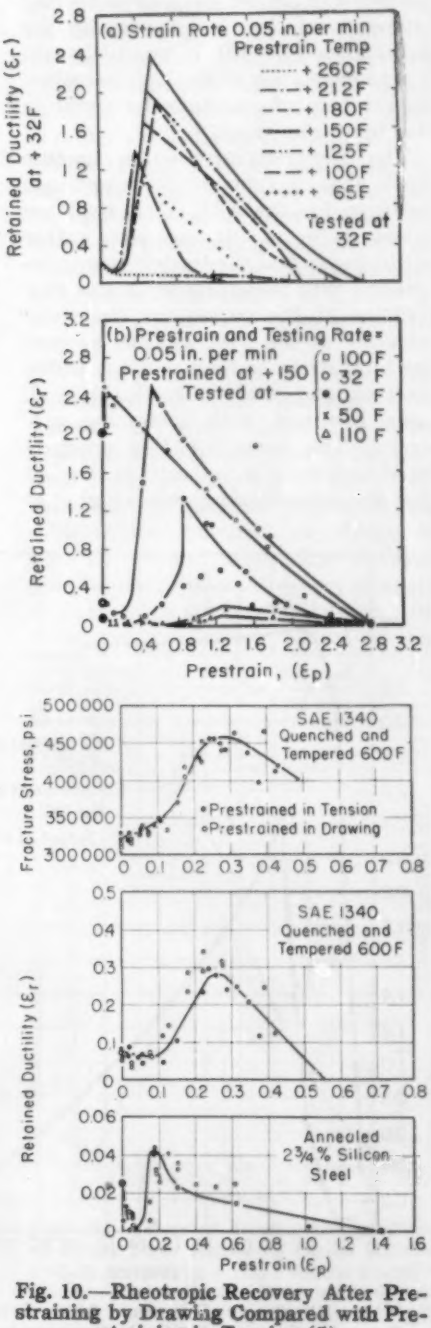


Fig. 8.—Effect of Testing Temperature on the Ductility of Commercially Pure Zinc Showing the Normal Transition Temperature in the Vicinity of +100 F as well as a High-Temperature Embrittlement (7).

Fig. 9.—Retained Ducility as a Function of the Prestrain Showing That the Magnitude of the Prestrain Necessary to Effect a Rheotropic Improvement Is Independent of the Prestrain Temperature, but Dependent on the Testing Temperature (7).



simpler curves C and B, while branch s-t appears to serve simply as a connection between these two. The factor that contributes to a decreasing ductility with increasing prestrain over the range of prestrains given by rs can be effective only at small strains; therefore the portion rs of curve D has been labeled the metastable branch. The portion of the curve between the ductility maximum and the abscissa intercept (tu) appears to represent the simple dependence of ductiiity on prestrain as described above. This branch of the curve has been labeled the stable portion, while the portion of the curve between these two (st) is the transition branch. The labeling of section tu of curve D as a stable portion of the curve implies that at temperature T_3 (or any subtransition temperature) the metal is initially in some impaired condition, which is overcome by prestraining at a supertransition temperature. The magnitude of this impediment at T_3 is readily evaluated by extrapolating the stable branch of the retained ductility-prestrain curve back to zero prestrain. This extrapolation along with the stable portion of the curve represents the normal effect of prestrain in the absence of the rheotropic impediment as given by Eq 1. The intersection of the extrapolation with the ductility axis (x in Fig. 1) yields the value of ϵ_B. The normal low-temperature embrittlement for temperature T_3 then is shown by $\Delta\epsilon_1$ in the right-hand chart in Fig. 1, while the shaded area represents the rheotropically embrittled portion.[4]

An extension of the supertransition branch of the ductility-testing temperature curve to the testing temperature T_3 again yields this same value of ductility (x) at T_3. Apparently transition temperature effects are a result of this rheotropic impediment.

Rheotropic Behavior of Steel

The effect of tempering temperature on rheotropic behavior has been investigated for quenched-and-tempered SAE 1340 steel. The studies on this material consisted of quenching and then tempering groups of specimens at temperatures between 300 and 1100 F. Specimens from each group were stretched various amounts at room temperature after which these stretched specimens were tested by means of an unnotched tension test at −321 F. With this mild test, the transition temperature for the steel has been

[4] It might be mentioned here that Sykes in 1920 (6), on the basis of tests made on nickel, molybdenum, and on an aluminum alloy, stated that a "worked sample will retain its power of elongation to a lower temperature than an unworked metal."

Fig. 10.—Rheotropic Recovery After Prestraining by Drawing Compared with Prestraining in Tension (5).

shown to lie between room temperature and −321 F only when it is tempered between 500 and 700 F (5). Consequently, the steel exhibited complex retained ductility-prestrain curves characteristic of rheotropic embrittlement when it was tempered at 500, 600, and 700 F, while tempering at higher temperatures (800 and 1100 F) produced the simpler type of retained ductility-prestrain curves as shown in Fig. 2.

It is interesting to note that an extrapolation of the stable branches of the three curves (tempered at 500, 600, and 700 F) that show rheotropic effects produces values for the ductility at zero prestrain which represent a natural extension of the ductility-tempering temperature curve at high-tempering temperatures, Fig. 3. Apparently the well-known 500–600 F embrittlement is a manifestation of the high transition temperature of materials tempered in this tempering range.

The enormous increases in fracture stress that accompany the rheotropic recovery for the SAE 1340 steel are shown in Fig. 4. It may seem rather surprising to find the fracture stress decreasing with increasing prestrains over portions of the curves for the steels tempered at 600, 700, and 800 F, since the total strain to fracture (sum of the prestrain and retained ductility) in all cases increased with increasing prestrain. The basis for this anomaly could undoubtedly be found in the fact that the stress-strain curve is higher at any total strain if the strain is made up of one low-temperature strain rather than a high-temperature strain followed by a low-temperature strain.

An interesting behavior in these two-step tests was found when the strain cycle discussed up to this point was reversed, that is, when the first strain was performed at the low temperature and the second strain at the higher temperature (room temperature). Here again, if the transition temperature does not lie between the prestraining and testing temperatures, the dependence of retained ductility on the prestrain is given by Eq 1 as shown for SAE 1340 steel tempered at 800 F in Fig. 5(*a*). The value of ϵ_A is the low-temperature ductility and the value of ϵ_B is the high-temperature ductility in this case. When the brittle material (tempered at 600 F) was first stretched at −321 F and then tested at room temperature, it was found that strains even close to the fracture ductility at −321 F were not very harmful in terms of reduction of room temperature ductility, Fig. 5(*b*). Here again Eq 1 described the retained ductility-prestrain relationship so long as the extrapolated value for the ductility at −321 F in the absence of the rheotropic impediment is used for the value of ϵ_A. Apparently if straining at subtransition temperatures is extraordinarily harmful, the damage is completely wiped out by the room temperature strain that follows. Although there is insufficient data to be sure that the prestrain (abscissa) intercept in Fig. 5(*b*) is the same as the retained ductility (ordinate) intercept in Fig. 2, data obtained on annealed SAE 1340 steel indicate that these two intercepts are the same, as shown by the intercepts of the extrapolations in Figs. 6(*b*) and (*c*).

Rheotropic Behavior of Zinc

Although most of the work on rheotropy to date has been done on steels, it has been found that a commercially pure zinc (99.99 per cent) can also have

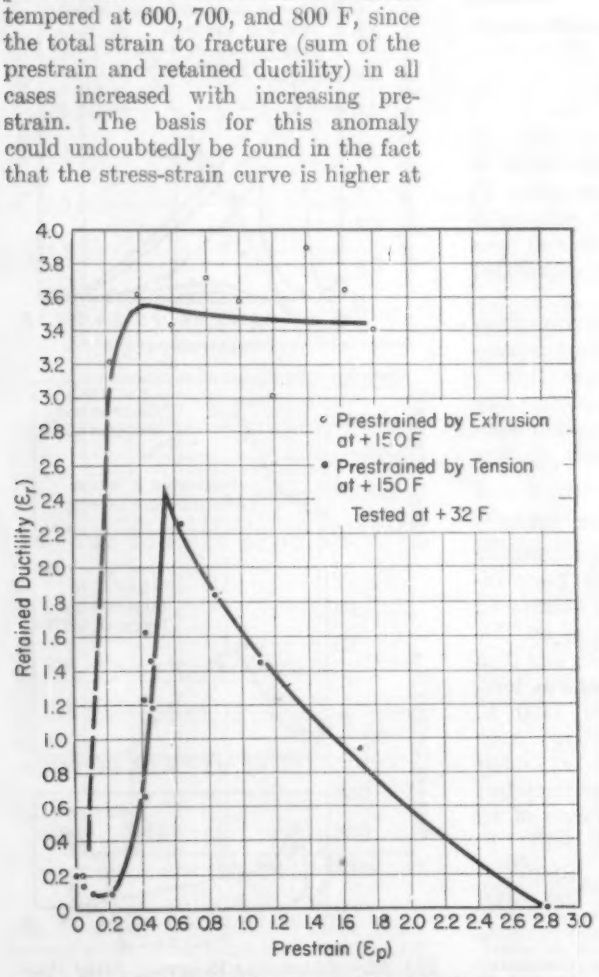


Fig. 11.—Rheotropic Recovery After Prestraining by Extrusion Compared with Prestraining in Tension.

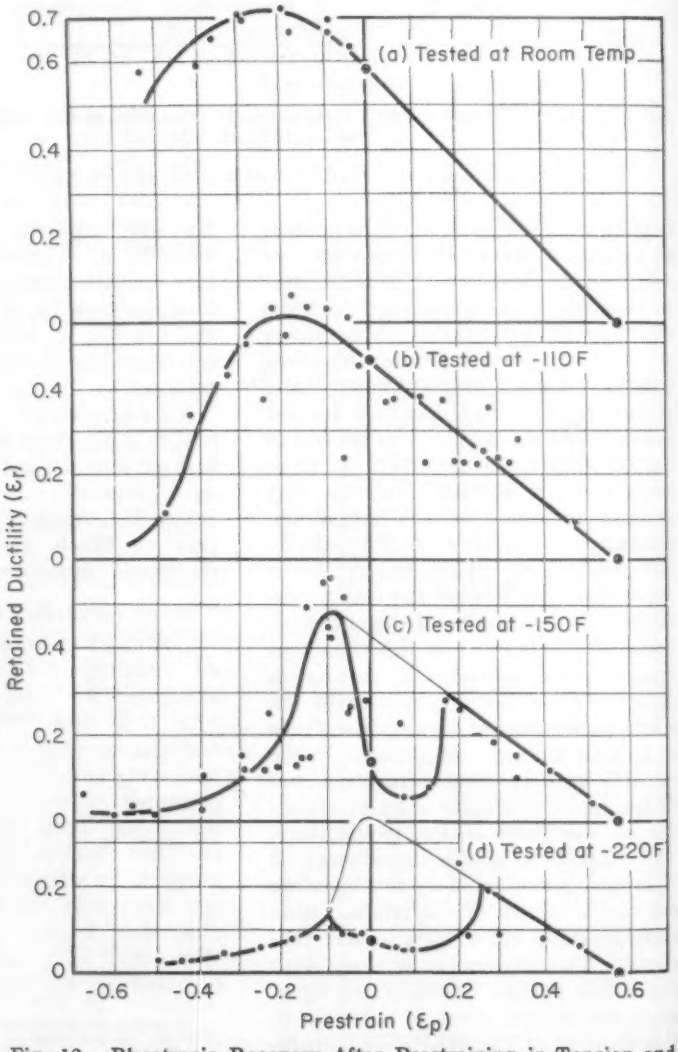


Fig. 12.—Rheotropic Recovery After Prestraining in Tension and in Compression at Room Temperature. Testing was in Tension at Indicated Temperatures.

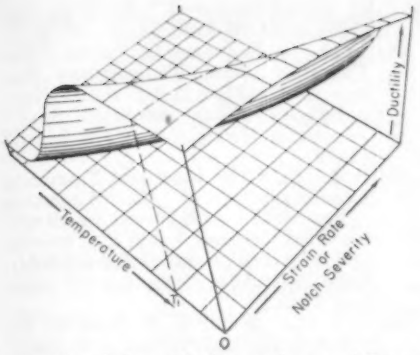


Fig. 13.—Schematic Dependence of Ductility on Testing Temperature, Strain Rate, and Notch Severity.

its subtransition temperature ductility improved by first working the zinc at a supertransition temperature as shown in Fig. 7 (**7**). Zinc, when strained at a slow rate, not only shows the transition temperature type of embrittlement, but it also exhibits a high-temperature embrittlement, Fig. 8. Consequently, prestraining at high temperatures at which this embrittlement is effective prevents the rheotropic recovery in subsequent testing. This accounts for the fact that there is no ductility increase in Figs. 7(*a*) and (*b*) with increasing prestrain.

Since rheotropic effects are found in both steels (body-centered cubic crystal structure) and zinc (hexagonal crystal structure), it is suggested that this behavior is quite general for materials which exhibit a transition temperature.[5] Further, it will be shown below that rheotropic effects can be encountered even when the prestraining and testing are accomplished at the same temperature.

[5] Actually the author has not yet been able to detect a rheotropic condition in Armco iron.

Characteristics of Rheotropic Embrittlement

Effect of Testing Temperature:

The length of the metastable and transition branches of the retained ductility-prestrain curve determines the magnitude of prestrain necessary to overcome the rheotropic impediment, and this in turn has been shown to depend on how far the testing temperature is removed from the transition temperature. The data shown in Fig. 7 are replotted in Fig. 9 to show that the metastable and transition curves are independent of the prestrain temperature. Decreasing the testing temperature, on the other hand, increases the range of strains over which the metastable and transition effects occur, as shown in Fig. 9(*b*).

It is known that increasing the tempering temperature of quenched-and-tempered steels over the tempering range of 500 to 800 F decreases their transition temperature (**8**). This explains the movement of the peaks in Figs. 2(*c*), (*d*), and (*e*) to lower and lower prestrains until it completely disappears for the material tempered at 800 F.

Effect of Prestraining Method:

In a recent investigation of the influence of cold working on the mechanical properties of an aluminum alloy, it was shown that the ductility retained in a metal after it had been strained by some amount depended on the method of prestraining (**9**). Of the methods investigated, straining by tension reduced the ductility fastest; drawing was somewhat less harmful than tension; and extrusion was the least damaging of the working methods. These results suggest that rheotropic improvements may possibly be obtained with a higher resulting ductility if the prestrain is by some method other than stretching. Consequently specimens of SAE 1340 steel quenched and tempered at 600 F, as well as specimens of the $2\frac{3}{4}$ per cent silicon steel, were prestrained in drawing at room temperature and subsequently tested in tension at a subtransition temperature. The results obtained on these series, Fig. 10, indicate that prestrain by drawing produces about the same results as prestraining by stretching over the range of rather small strains investigated.

Prestraining zinc by extruding, on the other hand, produced results, Fig. 11, that were far superior to those obtained by prestraining in tension. As a matter of fact, along with an increase in hardness, the ductility of the zinc at 32 F was increased from an ϵ_1 value of about 0.2 to one of 3.5.

A number of steel specimens were also prestrained at room temperature in compression after which they were tested at a low temperature in tension.[6] Here again prestraining at the supertransition temperature improved the subtransition ductility as shown in Fig. 12. Since prestraining in compression produced a rheotropic recovery in terms of a subsequent tension test, these rheotropic effects cannot be con-

[6] A different heat of SAE 1340 steel was used for these precompression tests. After quenching and tempering (600 F), the SAE 1340 steel used for all the other work herein described exhibited a transition temperature between −220 and −321 F. After this same heat treatment, the material used for the precompression work showed a very sharp transition at −150 F.

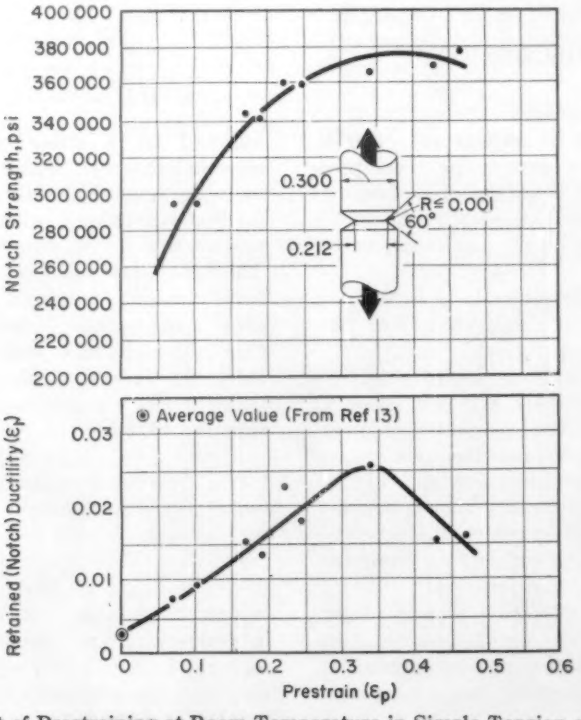


Fig. 14.—Effect of Prestraining at Room Temperature in Simple Tension on the Notched Properties at Room Temperature (5).

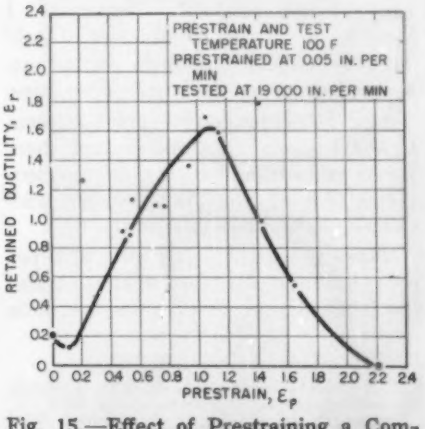


Fig. 15.—Effect of Prestraining a Commercially Pure Zinc at a Strain Rate of 0.05 in. per min at + 100 F on the Ductility Retained at a Strain Rate of 19,000 in. per min at +100 F (7).

sidered simply as the result of a realignment of microcracks.

Rheotropic Effects at Constant Straining Temperature:

Sudden property changes quite like those encountered in the vicinity of the transition temperature are thought to result not only when testing temperatures are varied but also when metals are strained under varying notch conditions or at varying strain rates. Strain rate and notch embrittlement are related to low-temperature embrittlement through their influence on the transition temperature as shown schematically in Fig. 13. Notice that increasing the notch severity or the strain rate moves the ductile-brittle transition to higher temperatures. As a result of the movement of the transition temperature, it is possible to select a constant testing temperature, say T_1 in Fig. 13, and at that temperature cross the abrupt ductile to brittle transition by varying either the strain rate or the notch severity.

In order to determine whether or not crossing the transition temperature range in this manner at a constant straining temperature was rheotropic, a group of SAE 1340 steel specimens were strained various amounts at room temperature in an unnotched condition, after which notches of the type shown in Fig. 14 were machined into the specimens. These strained and notched specimens were then tested, again at room temperature, to produce the enormous increase in notch properties shown in Fig. 14.

Zinc specimens were used in the investigation of rheotropic behaviors at high strain rates. Unnotched zinc specimens, prestrained at a slow rate (0.05 in. per min) at +100 F, were tested at this same temperature and at a high strain rate (19,000 in. per min). Here again an enormous increase in ductility was found for the worked metal as shown in Fig. 15. These test results in Figs. 14 and 15 indicate that at least a portion of notch embrittlement and high strain rate embrittlement is rheotropic.

Acknowledgment:

The author acknowledges with pleasure the helpful discussions of W. M. Baldwin, Jr., and L. J. Ebert, and the permission of the Office of Naval Research to publish this report.

REFERENCES

(1) Z. Jeffries, Discussion to reference 6.
(2) E. J. Ripling, "Sub-Zero Properties of Metals Surveyed," *The Iron Age*, October 19, 26, 1950.
(3) E. J. Ripling and G. Sachs, "The Effect of Strain-Temperature History on the Flow and Fracture Characteristics of an Annealed Steel," *Journal of Metals*, Vol. 1, No. 2, p. 78 (1949).
(4) S. I. Liu, "The Flow and Fracturing Characteristics of the Aluminum Alloy 24S-T4 as Affected by Strain-Thermal History," *ONR Technical Report No. 19, Contract N6-ori-273/1*, Case Institute of Technology, November, 1949.
(5) E. J. Ripling and W. M. Baldwin, Jr., "Rheotropic Embrittlement of Steel," *Transactions*, Am. Soc. Metals, Vol. 43, p. 778 (1951).
(6) W. P. Sykes, "Effect of Temperature, Deformation, Grain Size and Rate of Loading on Mechanical Properties of Metals," *Transactions*, Am. Inst. Mining and Metallurgical Engineers, Vol. 64, p. 780 (1920).
(7) E. J. Ripling and W. M. Baldwin, Jr., "Rheotropic Brittleness: General Behaviors," *Proceedings*, Am. Soc. Testing Mats., Vol. 51, p. 1023 (1951).
(8) M. Baeyertz, W. F. Craig, Jr. and J. P. Sheehan, "Effect of Alloying Elements on Impact Properties of Quenched and Tempered Steels," *ONR Technical Report No. 22, Contract N6-ONR-274/1*, Armour Research Foundation, September, 1949.
(9) J. J. Lynch, E. J. Ripling, and G. Sachs, "Effect of Various Stress Histories on the Flow and Fracture Characteristics of the Aluminum Alloy 24ST," *Transactions*, Am. Inst. Mining and Metallurgical Engrs., Vol. 175, p. 435 (1948).

DISCUSSION

MR. A. B. WILDER.[1]—Will the author comment on his results with respect to the practical implications of lowering the Charpy impact transition temperature by the procedure discussed? I have in mind the possibilities of cold working tubular products in an attempt to improve the impact properties.

MR. F. GAROFALO.[2]—It would seem that the explanation associating rheotropic embrittlement with the reorientation of flaws is not in agreement with test results[3] published recently.

These results obtained on a 0.90 per cent chromium steel show that prestraining in tension at 75 F causes complete embrittlement in tension at −300 F. However, upon prestraining in compression at 75 F the material becomes ductile in tension at −300 F, the ductility increasing with net compressive strain.

This behavior should be reversed if the mechanism suggested by Mr. Ripling were operative.

MR. E. J. RIPLING (*author's closure.*)—In reply to Mr. Wilder's question about the practical possibilities of lowering transition temperatures by means of cold work, the author would like to refer to another project being conducted at Case School in which the effect of cold work on the engineering properties of steel is being determined.[4]

In this investigation it was shown that the Charpy transition temperature of rods could be lowered by as much as 150 F by sufficiently large reductions followed by a stress relief (without recrystallization). These large deformations, however, were only practical for low-carbon steel when the working process was by drawing through a die. The maximum practical reduction by tube drawing was not sufficient to effect a decrease in transition temperature although tube reduction by the Rockrite process looked promising. Other working processes such as rolling were not investigated.

Mr. Garofalo suggests that the rheotropic recovery cannot be a result of a realignment of microcracks since compressive prestraining is found to be so beneficial. This is certainly in agreement with Fig. 12 and the text in which it was stated that "since prestraining in compression produced a rheotropic recovery in terms of a subsequent tension test, these rheotropic effects cannot be considered simply as a result of realignment of microcracks."

[1] Chief Metallurgist, National Tube Division, United States Steel Co., Pittsburgh, Pa.
[2] Research Laboratory, United States Steel Co., Kearny, N. J.
[3] D. J. McAdam, Jr., G. W. Geil, and W. H. Jenkins, "Influence of Plastic Extension and Compression on the Fracture Stress of Metals," *Proceedings*, Am. Soc. Testing Mats., Vol. 47, pp. 554–572 (1947).
[4] Cleveland Ordnance District, Contract DA33-019-ORD-7, WAL Project No. 310/90-72.

A Rotary Bomb Oxidation Test for Inhibited Turbine Oils

By G. H. von Fuchs,[1, 2] E. L. Claridge,[1, 3] and H. H. Zuidema[1]

Most of the turbine oils in use today contain both a rust preventive and an oxidation inhibitor. A rust test and an oxidation test for evaluating inhibited turbine oil were published by von Fuchs, Wilson, and Edlund[4] in 1941. Modifications of these tests were later published as tentative ASTM methods. Tentative Method of Test for Rust-Preventing Characteristics of Steam-Turbine Oil in the Presence of Water (D 665 – 50 T)[5] was first issued in 1942. Method of Test for Oxidation Characteristics of Inhibited Steam-Turbine Oil (D 943 – 47 T),[6] was published as information in 1943 and has been a tentative method since 1947. Both of these tests are in widespread use by the manufacturers and users of turbine oil. The rust test is normally run for 24 hr, and significant conclusions can often be made from earlier observations. The oxidation test, on the other hand, requires considerably more time. Most inhibited oils last 1000 hr or more in this test, which is run at 95 C in the presence of water, oxygen at atmospheric pressure, and metallic copper and iron catalysts. For research and development purposes, the test has been quite valuable, but a much more rapid test is highly desirable for screening purposes and is almost mandatory for control purposes.

[1] Research Laboratory, Shell Oil. Co., Wood River, Ill.
[2] Present address, Niagara Falls, N. Y.
[3] Present address, Shell Oil Co., Houston, Tex.
[4] G. H. von Fuchs, N. B. Wilson, and K. R. Edlund, *Industrial and Engineering Chemistry, Analytical Ed.*, Vol. 13, pp. 306–312 (1941).
[5] 1950 Supplement to Book of ASTM Standards Part 5, p. 189
[6] 1949 Book of ASTM Standards, Part 5, p. 1110.

Development of Rotary Bomb Test

Method D 943 cannot be accelerated appreciably, for the test temperature is limited by the boiling point of water. Bomb tests, on the other hand, are free from temperature restrictions imposed by vapor pressure. They have been used for a number of years for studying the oxidation stability of various products. Method of Test for Oxidation Stability of Gasoline (D 525 – 49)[7] is an example of such a test. In the case of liquids of low viscosity, for example, gasolines, the rate of diffusion of oxygen is an insignificant factor in the over-all reaction rate. Agitation is therefore unnecessary, and Method D 525 is a stationary test. However, turbine oils have viscosity values sufficiently high at the desired test temperature so that the oxidation rate is limited by the diffusion rate in a stationary test. Agitation of the bomb is therefore necessary.

Apparatus:

The bomb used in the present test is shown in Figs. 1 and 2. It is a modification of the Parr bomb used in Method of Test for Sulfur in Petroleum Products and Lubricants by Bomb Method (D 129 – 51).[8] It is made of stainless steel and is connected to a pressure gage (0–300 psi) by means of a 10-in. length of stainless steel bar stock drilled to a $\frac{1}{8}$-in. bore and equipped with a needle valve for introducing oxygen. The inside diameter and depth of the bomb are approximately 2.5 and 4.5 in., respectively. The gasket may be either lead or neoprene. The cap of the bomb is made of cold-rolled brass to eliminate galling, which was experienced when the bomb and cap were both made of stainless steel. The glass liner has an inside diameter and depth of approximately 2.0 and 3.5 in., respectively. The top is ground flat to accommodate a flat glass lid, also ground, which has a $\frac{1}{16}$-in. hole to allow free passage of oxygen.

The oil bath is shown in Fig. 3. The bomb, which is held at an angle of 30 deg with the horizontal, is rotated at 100 ± 5 rpm while completely immersed in the oil (bright stock), with only the gage and a portion of the stem extending above the oil level. The bath is equipped with suitable stirrers, heaters, and a thermostat capable of holding the temperature at 150 ± 0.2 C.

[7] *Ibid*, p. 930.
[8] 1950 Supplement to Book of ASTM Standards, Part 5, p. 169.

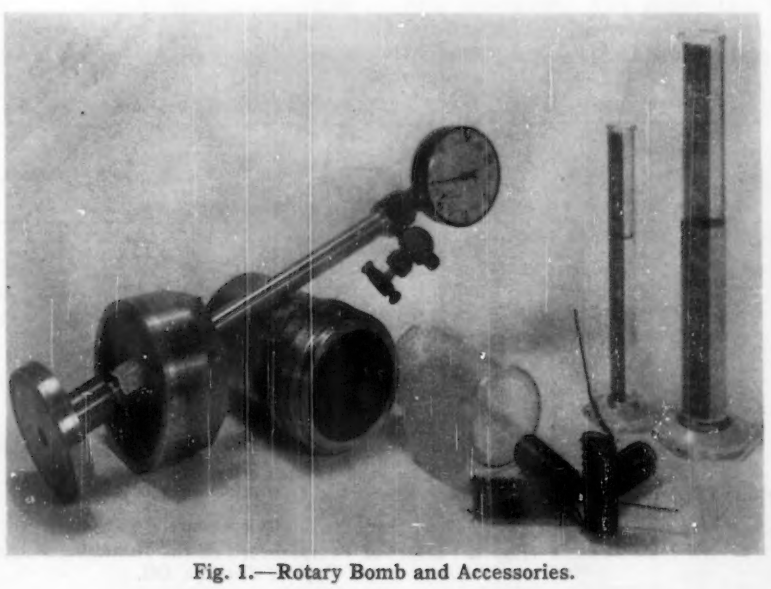


Fig. 1.—Rotary Bomb and Accessories.

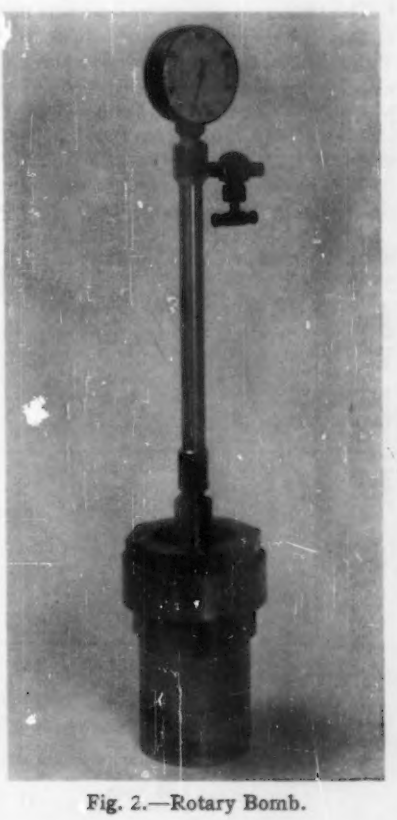


Fig. 2.—Rotary Bomb.

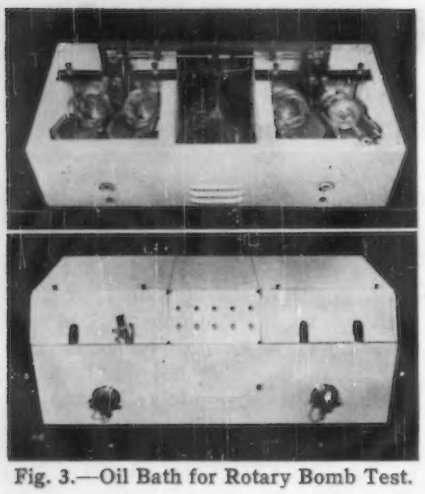


Fig. 3.—Oil Bath for Rotary Bomb Test.

Test Procedure:

The bomb, lid, and connecting stem are washed with ASTM precipitation naphtha and then with acetone. If they are clean at this point they are either rinsed with distilled water and oven-dried or rinsed again with naphtha and air-dried. Any stain or sludge remaining on the interior of the bomb after the acetone wash is removed by soaking in warm alcoholic potassium hydroxide. The bomb is then thoroughly washed with hot distilled water and oven-dried. The glass liner and lid are first washed with organic solvents and then soaked in aqua regia, cleaning acid, or a hot saturated oxalic acid solution. They are then thoroughly washed with hot distilled water and oven-dried.

The catalysts consist of 3 meters each of No. 14 gage iron and copper wire. The surfaces are prepared and the coils wound in the manner described in Method D 943. The coils are then cut into four equal lengths, and each section is extended about 5 cm. The four coils, which act as baffles as well as catalysts, are placed in the glass liner and the "tails" twisted together so that all of the pieces are in electrical contact with one another. The oil (60 ml) is poured into the liner. Then the lid is put in place and the liner shaken to insure complete wetting of the metal surfaces by the oil. The water (20 ml) is then added.

The liner is placed in the bomb, with a pad of glass wool beneath the liner and above the lid. The bomb is closed by means of a long-handled wrench. Less difficulty is experienced in sealing the bomb if neoprene rather than lead gaskets are used. The bomb is flushed three times with oxygen at 90 psi.[9] It is then charged at 90 psi and room temperature. The gages are calibrated periodically against a Bureau of Standards gage. The bomb is tested for leaks by immersing the whole assembly in water at room temperature. If there is no visible leak and the gage reading remains constant for 15 min, the assembly is dried and placed in the rotating carriage in the oil bath.

[9] Introduction of oxygen should always be done through a reducing valve set at 90 psi.

The bath temperature should be slightly above 150 C when the bomb is inserted. The temperature will then level off at 150 C much sooner. Pressure is recorded every 10 min during the warm-up period. Zero time is taken at the midpoint between the start of the test and the attainment of maximum pressure. After the pressure has leveled off, the readings may be taken somewhat less frequently. The test is terminated when the pressure has fallen to a point 25 psi or more below the maximum. The time at the 25 psi drop is taken as the end point. A typical time-pressure curve is shown in Fig. 4.

At the conclusion of the test the bomb is allowed to cool to room temperature before it is opened. The remaining oxygen is released slowly through the needle valve, after which the bomb is opened and cleaned.

Safety Precautions:

Regarding the hazards of the test, no difficulties have been encountered under the test conditions outlined above. Exploratory tests at higher pressures indicated that initial oxygen pressures up to 500 psi could be tolerated. However, when the initial oxygen pressure was increased to 600 psi the reaction be-

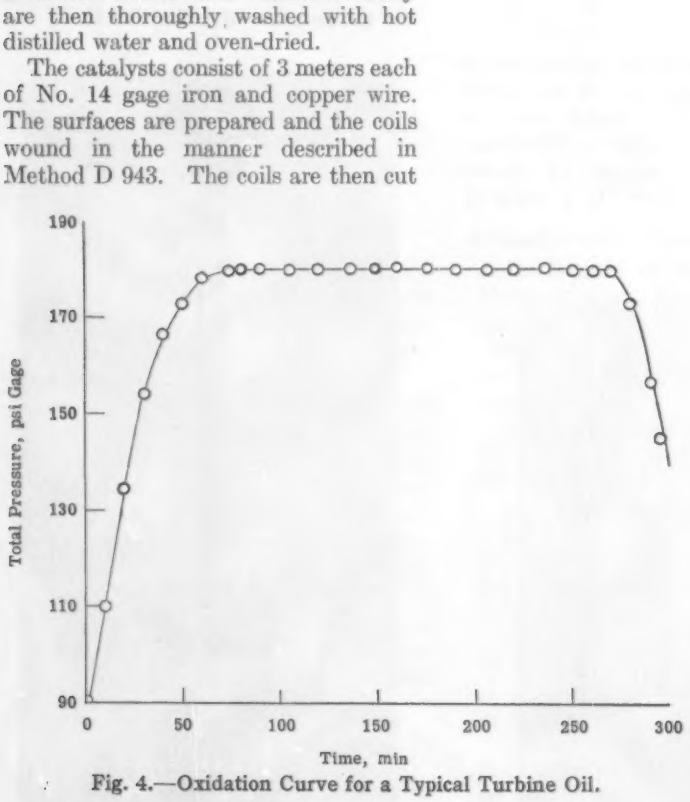


Fig. 4.—Oxidation Curve for a Typical Turbine Oil.

Maximum pressure attained	70 min.
Zero point	35 min.
End point	295 min.
Induction period	260 min.

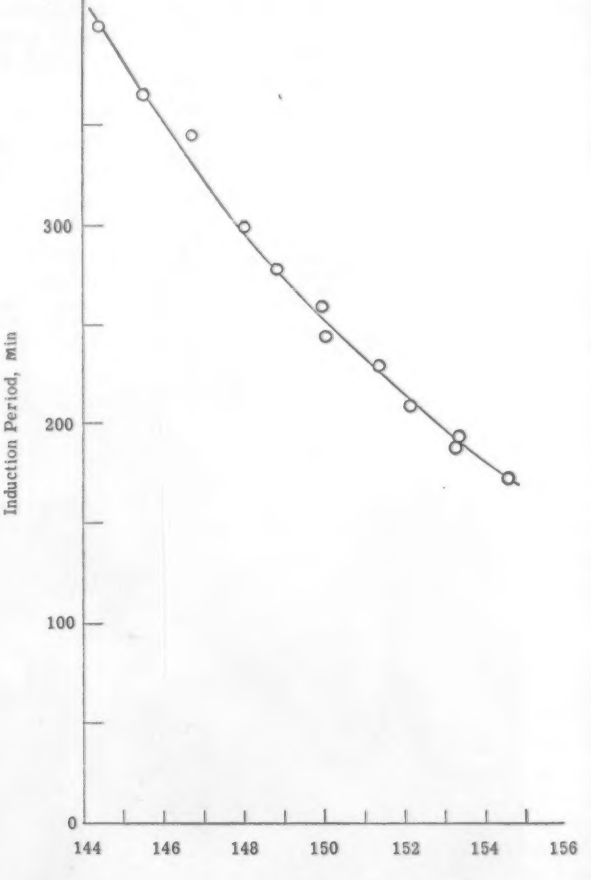


Fig. 5.—Effect of Temperature on the Induction Period of a Typical Turbine Oil.

TABLE I.—EFFECT OF SPEED OF ROTATION ON INDUCTION PERIOD OF TURBINE OIL

Viscosity of Oil, Saybolt Univeral sec, at 100 F	Induction Period, hr:min				
	Stationary Bomb	Rotary Bomb			Tumbling Bomb, 40 rpm
		75 rpm	100 rpm	125 rpm	
150 (oil A)	...	2:25	2:35	...	2:30
150 (oil B)	...	2:55	2:50	...	2:50
300 (oil C)	...	3:55	3:50	...	3:50
400 (oil D)	13:00	4:00	3:30	3:25	3:30
400 (oil E)	...	3:30	2:45	...	2:55
400 (oil F)	...	...	1:40	...	1:40
400 (oil G)	3:30	...	0:30	...	...
500 (oil H)	...	4:25	4:05	...	4:10
650 (oil I)	...	...	4:15	4:25	4:10

came so violent that the lead gasket ruptured.

Failure of a gasket is quite rare under the test conditions prescribed. However, a transparent protective shield should be placed between the test assembly and the operator to protect him, primarily against being splashed with oil from the bath, in the event of a failure.

Effect of Temperature:

Temperature control, as in all oxidation tests, is a very important factor. The effect of temperature upon the induction period of a typical turbine oil is shown in Fig. 5. It will be observed that a deviation of 1 C from the nominal value of 150 C resulted in a change in induction period of about 10 min. The bath temperature is therefore held as close to 150 C as possible, preferably within ±0.2 C.

Effect of Rate of Rotation:

While agitation is necessary to provide ready access of oxygen, the rate of rotation in the range of 100 ± 5 rpm is not critical. This point is brought out in Table I, which contains data on oils ranging in viscosity from 150 to 650 Saybolt at 100 F. Tests were run in a stationary bomb, in the rotary bomb at 75, 100, and 125 rpm, and in a tumbling bomb at 40 rpm. The tumbling bomb involved an end-over-end motion which effected very intimate contact between liquid and vapor. Agreement between the 100 rpm rotary and the tumbling test is seen to be excellent. This indicates that diffusion rate is not a significant factor in the rotary bomb test.

Precision:

The precision of the rotary bomb test has not been studied extensively, but the data available indicate it to be reasonably good. In the course of regular routine work one sample was run 15 times, at weekly intervals. No particular precautions were taken with this sample except to store it in glass in the dark to prevent any possible deterioration in storage during the testing program. The results, shown in Table II, indicate an average deviation from the mean of 10 min and a standard deviation of 14 min. These figures are considered to be quite satisfactory for so complex a test procedure. The bomb test is a much more reliable criterion of stability for such samples than chemical tests for inhibitor content, since stability is affected not only by the inhibitor but also by such factors as quality of the base oil and degree of contamination.

Table II.—Precision of Rotary Bomb Test.

Test	Induction Period, hr:min	Test	Induction Period, hr:min
No. 1	3:55	No. 9	4:30
No. 2	3:45	No. 10	4:10
No. 3	3:55	No. 11	3:55
No. 4	3:55	No. 12	3:55
No. 5	4:05	No. 13	3:50
No. 6	4:00	No. 14	4:05
No. 7	4:10	No. 15	3:25
No. 8	4:00		
Mean induction period			3 hr, 58 min
Average deviation from mean			10 min
Standard deviation			14 min

Correlation of Rotary Bomb Test with Method D 943

The principal differences in the conditions used in the rotary bomb test and Method D 943 are the temperature (150 C compared to 95 C) and the oxygen concentration (approximately seven atmospheres compared to one). Prediction of the D 943 "life" of an oil from its induction period in the rotary bomb is, therefore, analogous to the prediction of the storage life of a gasoline at some fixed temperature and one atmosphere of air, or $\frac{1}{5}$ atmosphere of oxygen, from the induction period, which is normally run at 100 C and about eight atmospheres of oxygen (100 to 102 psi gage at room temperature).

The effect of temperature and oxygen pressure upon the rate of oxidation of gasoline has been studied in detail by Walters, Yabroff, and Minor,[10] who showed that the effect of these two variables can be expressed by the following equations:

$$\log \text{gum time (constant oxygen pressure)} = A + \frac{B}{T}$$

and

$$\log \text{gum time (constant temperature)} = C + D \log P$$

where A, B, C, and D are constants for a given gasoline, T is the absolute temperature, and D is the oxygen pressure. "Gum time" is the time required to form 10 mg of gum per 100 ml of gasoline under a given set of conditions. B and D are the temperature- and oxygen-pressure coefficients, respectively.

Walters, Yabroff, and Minor meas-

[10] E. L. Walters, D. L. Yabroff, and H. B. Minor, *Industrial and Engineering Chemistry*, Vol. 40, pp. 423–428 (1948).

TABLE III.—SUMMARY OF DATA OF WALTERS, YABROFF, AND MINOR ON STABILITY OF GASOLINES.

Sample	Induction Period at 100 C and 100 psi Oxygen, hr	10 mg Gum Time at 100 C and 100 psi Oxygen, hr	*B* Value	*D* Value	Calculated 10 mg Gum Time at 90 F, Air, months	Ratio of Gum Time at 90 F, Air, months to Induction Period, at 100 C and 100 psi Oxygen, hr
No. 1	9.08	>8.90	6180 or 5680	−0.108	>86 or >43	>95 or >47
No. 2	10.08	5.17	5250	−0.045	11	1.1
No. 3	15.50	>15.0	5160	−0.515	>155	>10
No. 4	4.50	3.08	6010	−0.312	50	11
No. 5	5.25	4.53	6050	−0.116	38	7.3
No. 6	3.67	1.18	5280	−0.086	3.0	0.82
No. 7	5.75	3.67	5110	−0.369	21	3.7
No. 8	6.33	5.03	5070	−0.140	12	1.9
No. 9	4.00	1.25	4800	−0.178	2.4	0.60
No. 10	3.96	1.30	4630	−0.122	1.6	0.41
No. 11	0.38	0.09	5370	−0.028	0.22	0.58
No. 12	>24.0	0.36	5100	0.00	0.5	>0.02
No. 13	2.50	0.27	4940	−0.239	0.75	0.30
No. 14	1.25	0.024	4770	−0.510	0.15	0.12
No. 15	5.10	2.55	5880	−0.134	18	3.5
No. 16	6.33	3.78	6040	−0.140	34	5.4
No. 17	1.08	0.92	5150	−0.060	1.8	1.7
No. 18	1.50	1.25	5320	−0.061	3.2	2.1
No. 19	3.92	3.92	5830	−0.069	20	5.1
No. 20	3.75	>3.45	6030	−0.500	>115	>30
No. 21	4.33	3.67	5060	−0.064	6.5	1.5
No. 22	13.25	10.55	5190	−0.048	21	1.6

ured the induction period and the gum time at 100 C and 100 psi oxygen pressure for 22 gasolines. The samples differed widely in composition but were all representative of commercial blends. Gum times were also measured at lower temperatures and oxygen pressures, and the *B* and *D* values were calculated for each sample. The results are summarized in Table III. The calculated gum times shown in this table were in general in good agreement with observed values obtained in storage tests conducted in a thermostated room. However, the storage life was by no means proportional to the induction period, as shown by the wide variation in the ratio of storage life to induction period in the last column of Table III. Any variation in the rate of gum formation within the induction period as well as in *B* and *D* values is, of course, reflected in this ratio.

Despite the fact that the rotary bomb results are based on a pressure drop, whereas Method D 943 measures neutralization number, the correlation between the two might reasonably be expected to be better than that shown between the induction period and storage stability of gasoline. Most turbine oils show a relatively sharp break in their oxidation curves at the end of the induction period. The induction period is about the same, therefore, regardless of whether it is based on oxygen absorption, neutralization number, or any other conveniently measured oxidation product. Both the temperature and oxygen pressure extrapolations are less in going from the rotary bomb conditions to Method D 943 than in going from the conditions of the gasoline induction bomb to storage.

TABLE IV.—EFFECT OF OXIDATION INHIBITORS UPON CORRELATION BETWEEN BOMB TEST AND METHOD D 943–47 T.

Oil	Inhibitors	Method D 943–47 T, hr	Time in Bomb Test, hr : min	Ratio of Method D 943–47 T to Bomb Test
No. 1	2,6-Ditertiarybutyl-4-methyl phenol	650	1:50	355
No. 2		1100	2:40	410
No. 3		1200	3:45	320
No. 4		1540	4:20	355
No. 5		1580	4:10	380
No. 6		1600	4:05	390
No. 7		1630	4:25	370
No. 8		1750	4:15	410
No. 9	Phenyl-α-naphthylamine	500	2:30	200
No. 10		1450	5:50	250
No. 11		2440	12:30	185
No. 12		2780	12:20	225
No. 13	Experimental inhibitor A	630	4:15	150
No. 14		890	4:15	210
No. 15	Experimental inhibitor B	1360	0:30	2700
No. 16		1730	1:00	1700
No. 17		1800	1:10	1500
No. 18		2400	1:30	1600
No. 19		2500	0:45	3300

No systematic study of temperature and oxygen pressure coefficients has been made in the rotary bomb. However, a comparison of rotary bomb induction periods and D 943 data on turbine oils of varying composition indicates that the oxidation inhibitor is an important factor in determining the ratio between "life" of an oil in the longer test to its induction period in the bomb. Typical data are shown in Table IV. It will be observed that this ratio is of the order of 350 to 400 for oils inhibited with 2,6-ditertiarybutyl-4-methyl phenol, but that it is considerably lower for oils containing phenyl-α-naphthylamine. Use of experimental inhibitor A resulted in an even lower ratio, while oils containing experimental inhibitor B showed a very much higher ratio.

Thus the prediction of the behavior of an oil in the D 943 test from the bomb test can be very misleading with oils of unknown composition. However, the bomb test is capable of providing very valuable information within a relatively short time (usually within a working day) on products of known composition.

Acknowledgment:

The authors wish to express their thanks to V. Anastasoff, E. J. Jahn, M. A. McClintock, N. B. Wilson, and A. G. Uzzell of the Shell Oil Co. for their cooperation in the development of the rotary bomb test.

Discussion of Paper on the Effects of Shot Peening on Damage Caused by Cavitation[1]

S. E. McCrary.[2]—Mr. Grossman has made some fascinating tests which demonstrate that shot peening can reduce cavitation erosion under certain conditions. His explanation, however, is not valid unless we are willing to accept the assumption that liquid impact of collapsing bubbles causes erosion through mechanical impact.

I challenge that assumption in spite of voluminous proof which has been submitted by many experimenters based on hydrodynamic and thermodynamic theories. A few experimenters, including Mr. Grossman, concede that electrochemical effects might contribute to erosion, but nearly every experiment reported in scientific literature on cavitation erosion attempts to prove rather than test the mechanical impact theory.

Mr. Grossman uses water at room temperature and pressure, allegedly distilled and degassed to minimize electrochemical effects. It occurs to me that the observed erosion may still be due, primarily, to electrochemical action. Remember Helmholtz' theory of liquid surface. It occurs to me that cavitation bubbles could be, by virtue of their surfaces, little vehicles impinging the metal surface, not with mere neutral water, but with concentration of H and OH ions. If this is true then we might expect cavitation bubbles to be highly corrosive.

I suggest that Mr. Grossman repeat his test with some nonpolar liquids as the medium at various temperatures and pressures to find out whether observed effects would agree with the mechanical impact theory. It might be interesting to use mercury or gallium as the liquid.

Surely the mechanical impact theory must be questioned so long as the experimenters are not able to explain fully the anomalies which cast doubts upon its validity.

Mr. Grossman (*author's closure*).—The author wishes to thank Mr. McCrary for his interesting and noteworthy comments. The idea of relating Helmholtz' theory of liquid surfaces and cavitation damage is novel, and it may help to a more complete understanding of the phenomenon. The purpose of these tests was to explore an economically feasible engineering method to mitigate the damage caused by cavitation—regardless of the underlying mechanisms causing that damage. The additional tests suggested by Mr. McCrary would enrich our basic knowledge but were beyond the specific scope of this investigation. It should be further recalled that cavitation can cause erosion in glass, ceramics, and other nonmetals, where electrochemical action is hardly conceivable.

[1] Nicholas Grossman, "The Effects of Shot Peening on Damage Caused by Cavitation," ASTM Bulletin, No. 183, July, 1952, p. 61 TP 107).

[2] Department of the Navy, Bureau of Ships, Washington, D. C.

Apparatus for Producing High Humidity

By James A. Murray[1]

THE problem of producing air at controlled humidity has concerned many investigators in recent years. A survey of the literature of the past twenty years indicates approximately 300 articles and patents dealing with this problem. Most of the methods described, however, are designed to control humidity at some level well below that of saturation. The production of humidities of 95 per cent or higher presents other problems. The controls may be much simplified if the objective is to produce as nearly a saturated atmosphere as possible, but the attainment of 100 per cent relative humidity is difficult.

Many high-humidity rooms make use of more or less finely divided spray introduced into the room through spray nozzles to obtain the desired humidification. Such a system has two major disadvantages: the fine nozzles tend to clog with dirt particles carried by the water, and the humidification system either must be shut down if workers are present in the room or the workers must wear raincoats for protection. In addition, air circulation is usually poor unless circulating fans are provided. A standard fan motor will not have a long life if subjected to this high humidity, and frequently the forced air circulation is abandoned to save maintenance costs.

Another method of attaining high humidity is to bleed steam into the air which is circulating. This is effective if circulation is complete and if the extra heat introduced by the steam is either not objectionable or can be removed by auxiliary equipment. This removal of excess heat introduces additional equipment and complications.

The desirable objectives of an apparatus for producing high humidity may be listed as follows:

1. It should be built of standard equipment as far as possible.
2. Forced circulation to all parts of the room should be provided.
3. Electrical motors and controls within the humidified room should be avoided.
4. Temperature control, if required, should be simple.
5. The production of a fog, mist, or spray should be avoided.

The equipment shown in Fig. 1 meets these objectives. No claim is made for originality in the use of this principle; in fact, it is merely an adaptation of the principle of a laboratory aspirator used as an air pump to a larger scale problem.

The essential part of the apparatus consists of a 6-in. Schutte Koerting fume scrubber mounted on a rectangular tank. Water from this tank is continuously recirculated by means of a centrifugal pump installed outside the humidified room. This water passes through a ½-in. spray nozzle in the scrubber and on passage through the Venturi throat of the scrubber induces air through the inlets. This air is released in the receiving tank where it frees itself of entrained water and discharges through four 3-in. elbows directed toward the corners of the room. A quiet box is formed in one end of the receiving tank by a submerged perforated baffle. A float valve automatically adds cold water to the system to replace any loss through vaporization, leakage, or temperature control.

Provision has been made for temperature control if this is needed. A recording-controlling thermometer is installed outside the humid room. This thermometer is actuated by a mercury-filled bulb with a 10-ft lead. Since the problem in this particular installation is one of cooling rather than heating, only the cooling equipment has been installed. Elevated temperatures may be obtained by the use of immersion heaters in the receiving tank if desired.

In order to operate at a lower temperature than ambient, the temperature controller is connected to a solenoid valve on a by-pass line on the pressure side of the circulating pump. As the room temperature rises, this solenoid valve opens and discharges the circulating warm water to waste. This drops the level in the receiving box and causes the float valve to admit cold water from the main water supply. By this means the air in the room is cooled as it passes through the cooler water, but the humidity also drops to some value below 100 per cent.

Operating data on the equipment are given in Table I. The column headed ambient temperature indicates the conditions when no attempt is made to control the temperature. The temperature rises to approximately 80 F and remains at this level with fluctuations rarely exceeding 0.5 F. The relative humidity is as close to 100 per cent as can be determined by using wet and dry bulb thermometers. The temperature difference between the thermometers is less than 0.1 F, the limit of accuracy of reading the thermometer. The atmosphere in the room is oppressive, characteristic of very high humidity, but there is no visible mist or fog.

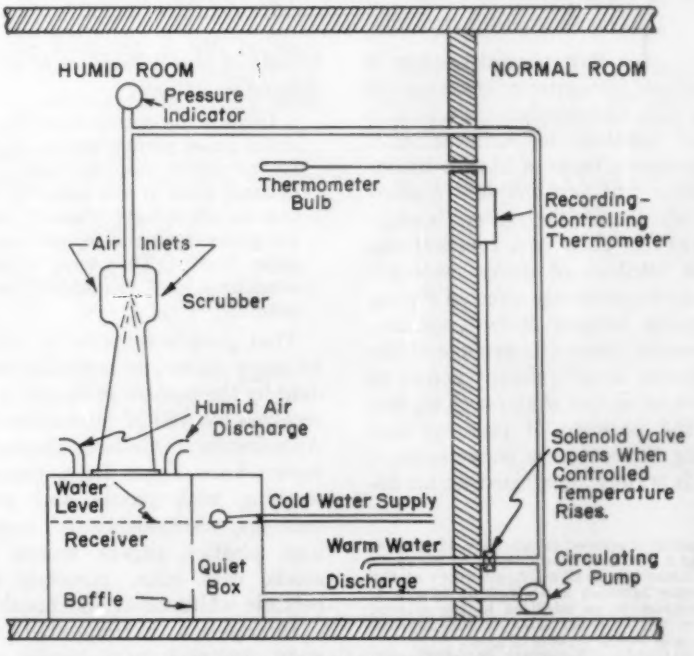


Fig. 1—Equipment to Produce High Humidity.

[1] Associate Professor of Materials, Massachusetts Institute of Technology, Cambridge, Mass.

The operating data obtained with controls set for 75 F are shown in the second column of Table I. Under these conditions, part of the circulating water is being pumped to waste and replaced by the cooler inlet water. This results in a circulating water temperature of 68 F which maintains the room at 75 F. However, the lower temperature of the water does reduce the relative humidity, in this particular case to 88 per cent.

TABLE I.—OPERATING DATA.

	Ambient Temperature	75 F
Volume of circulating water, gal per min	12	12
Water pressure at nozzle, psi, gage	20	20
Humid room temperature, dry bulb	79.9 F	74.7 F
Humid room temperature, wet bulb	79.9 F	72.0 F
Relative humidity, per cent	100	88
Inlet water temperature	...	50 F
Circulating water temperature	79.8 F	68.0 F
Velocity of air at discharge elbows, ft per min	1100	1100
Volume of circulating air, cu ft per min	215	215

This equipment is installed in a room with floor measurements of 12 by 13 ft and with an 11-ft ceiling height. Tests were made of the air in the corners of the room at floor level, 5 ft above floor level, and 9 ft above floor level. When operating at ambient temperature, the dry bulb temperature of the air at the 12 points was practically constant, varying only from 79.5 to 80.0 F, and the wet bulb temperature was within 0.1 F of the dry bulb in all cases. When operating at a controlled temperature of 75 F, the dry bulb temperatures varied from 74.0 to 75.0 F with the higher temperature at the 9-ft level. The relative humidity at floor level averaged 96 per cent; at the 5-ft level it averaged 95 per cent; at the 9-ft level it averaged 85 per cent. This deviation in humidity could probably be reduced by directing the air blasts from the discharge elbows toward a higher point in the room.

This equipment, after 18 months continuous operation, has required no maintenance other than the periodic lubrication of the ½-hp motor driving the circulating pump. No difficulties have been encountered with the temperature controller or the solenoid operated valve, and none are anticipated since these are located outside of the humid room. The apparatus provides a simple and relatively inexpensive method of attaining high humidities without the disadvantages encountered by either the spray method or the use of steam.

Gloss Evaluation of Materials*

By Richard S. Hunter[1]

SYNOPSIS

To materials engineers and technologists, gloss is a property of surfaces which causes them to have a shiny or mirrorlike appearance. This appearance cannot be measured; only specific reflectance capacities of surfaces can be measured. Although gloss may be associated with the capacity of a surface to reflect like a mirror, there is no single reflectance scale yielding values that correlate with the glossy appearance of *all* surfaces. This is because the capacities of surfaces to reflect light in and adjacent to the directions of mirror reflection are too complex and varied to be compared on any single scale. As a consequence, different gloss scales involving different geometric aspects of light reflectance have been developed. Each provides numbers correlating with the glossy appearance of the specific types of surfaces to which it is applicable. For certain types of glossy appearance, however, correlating methods of reflectance measurement do not exist.

To THE physicist, gloss is a matter of the *mirror efficiency* of surfaces. To the psychologist, it is a *perceptual attribute* of surfaces with special interest because of the binocular effects that are frequently associated with it. To the materials engineer, however, gloss is a *commercially important attribute* of many materials which may be adversely affected during compounding, forming, storage, and use.

The present paper fills in some of the gaps between these different points of view, reviews earlier work on gloss, and studies the problem of isolating and evaluating different gloss phenomena.

Gloss is widely recognized as an attribute of object surfaces which may be defined as follows:

> Gloss is the degree to which a surface simulates a perfect mirror in its capacity to reflect incident light. As thus defined, gloss is the capacity of a surface to reflect light which is responsible for glossy appearance, not the appearance itself. The term *glossiness* is sometimes used to identify the appearance.

That gloss is a matter of importance to many materials technologists is evident by the number of inquiries on gloss received by ASTM Committee E-12 on Appearance. Questions about gloss and luster have come from technologists working with paints and protective coatings, electrodeposited metal coatings, plastics, papers, waxes, stainless steels, cast irons, porcelain enamels, ceramic whitewares, and textiles.

Information is requested with respect to gloss phenomena and the methods of gloss measurement applicable to the individual products. In general, those inquiring may know little of the physics of gloss but, from their experience, they know much about the relation between glossiness and the technologies of the materials in question. Such technologists are accustomed to interpreting the appearance features in terms of (1) ingredients, (2) processing, and (3) exposure histories. As one paint chemist put it:

> "I cannot pretend to have a good understanding of the theoretical considerations involved in gloss measurements. Like most practical paint chemists, however, I am daily confronted with the necessity for gloss measurements or ratings. My chief concern is to have a numerical value, determined with an instrument, that gives substantial agreement with the visual rating of an experienced observer."

Although materials technologists are generally unfamiliar with the fundamentals of reflectance measurement, all express the hope that a single method of gloss measurement applicable to all materials may eventually be developed. Fear is expressed that the present trend toward a separate gloss scale for each type of material will confuse the situation and lead to an uneconomic and unnecessary multiplicity of instruments.

For those seeking a single gloss scale, there is encouragement in the simple traditional explanation of surface reflection. It is said that light reflected

* This paper is printed in advance of its presentation at a Symposium on Gloss to be sponsored by Committee E-12 on Appearance at the ASTM Spring Meeting in Detroit on March 4. At this symposium, in addition to the present paper, there will be other talks on the physical foundation and visual aspects of gloss.

[1] Henry A. Gardner Laboratory, Inc., Bethesda, Md. Now with Hunter Associates Laboratory, Falls Church, Va.

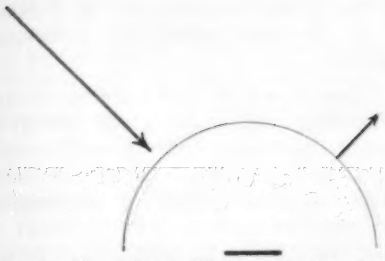


Fig. 1.—Traditional Picture of the Geometric Separation of Reflected Light Into Specular and Diffuse Components.

Fig. 2.—Seven Objects Illustrating the Seven Glossiness Classifications Given in the Text.

by a typical, substantially flat surface can be divided into a part reflected specularly (responsible for glossiness) and a part reflected diffusely (responsible for color). It is also said that when a beam of light strikes the specimen, the geometric distribution of reflected light may be represented by a graph of the type shown in Fig. 1. The specularly reflected light is represented by a vector in the direction of mirror reflection and the diffusely reflected light by a semicircle denoting uniform surface luminance in all other directions.

Further, it is said that specular reflection occurs at the skin of the surface and diffuse reflection in the granular structure beneath the skin. Specular reflection gives rise to shininess or glossiness, diffuse reflection to whiteness and color. The traditional differences between specular and diffuse reflection are given in Table I.

finally whites. If objects are arranged according to increasing specular reflectance, they vary from matte to mirrorlike about as follows:

Rating Scale for Glossiness

Non-Metallic:

1. Matte surfaces showing no highlights.
2. Low-gloss surfaces showing barely perceptible highlights.
3. Eggshell-gloss surfaces showing easily perceptible highlights.
4. Semigloss surfaces showing pronounced highlights, but indistinct mirror images.
5. High-gloss, shiny surfaces reflecting distinct mirror images.

Metallic:

6. Shiny, metallic surfaces of less than mirror quality.
7. Metallic surfaces of mirror quality.

In Fig. 2 seven objects are shown representing each of the glossiness classes.

TABLE I.—DIFFERENCES BETWEEN SPECULAR AND DIFFUSE REFLECTION.

	Specular Reflection	Diffuse Reflection
Distribution of reflected light....	In direction of mirror reflection	Diffused uniformly according to cosine of angle
Structural elements responsible.	Surface or skin of specimen	Pigment granules and cavities within specimen
Resulting appearance characteristic.....	Glossiness, or mirrorlike appearance	Lightness (expressed on black-gray-white scale) and color

When objects are arranged according to increasing diffuse reflectance, blacks come first, then grays and colors of intermediate diffuse reflectance, and

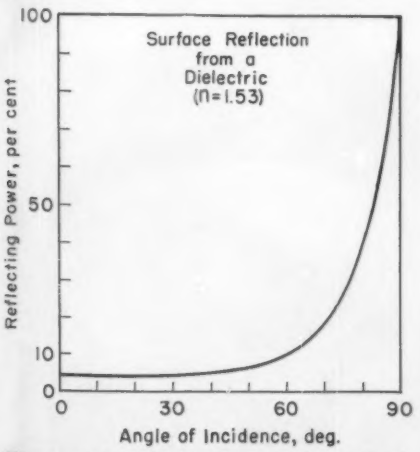


Fig. 3.—Specular (Surface) Reflectance as Function of Angle of Incidence for Dialectric with n = 1.53 According to Fresnel Equation.

From the foregoing it will be seen that there are two good reasons for considering gloss a specific unitary attribute of surfaces:

1. Gloss can be ascribed to a specific characteristic of object surfaces, namely the degree to which they simulate a perfect mirror in their capacities to reflect incident light.

2. It is possible to class real objects for glossiness on a rating scale which varies from matte to mirrorlike.

Actual Complex Picture of Gloss Goniophotometric Curves

In ascribing the reflectance responsible for glossy appearance to the skin of any surface, the traditional explanation is substantially correct. However, the precise manner in which a specimen surface will reflect an incident beam of light is determined by a complex set of factors not subject to measurement by a single number.

When a surface is optically smooth, Fresnel's equation establishes the fraction of an incident beam of light reflected by it in terms of:

1. The angle of incidence, i.
2. The refractive index of the material, n.
3. The extinction coefficient κ (nearly zero for nonmetals).
4. The state of polarization of the incident light. (Not considered in the present study since incident light is essentially unpolarized in the usual materials-viewing situation.)

The complete Fresnel treatment of surface reflection (4)[2] can be found in texts on physical optics, such as those

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

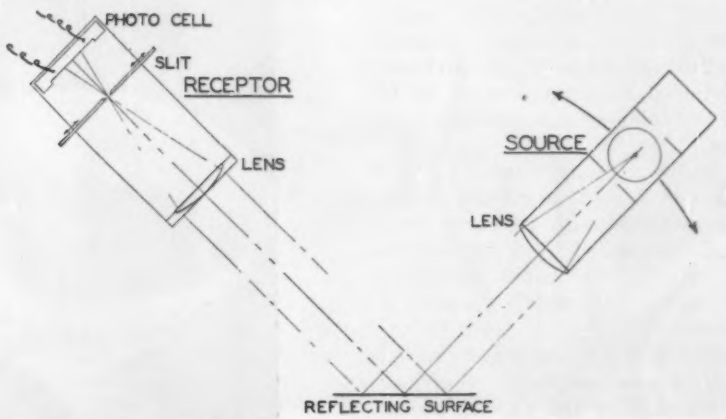


Fig. 4.—Diagram of Goniophotometer in Which Plane of Specimen and Direction of Incident Light Beam May Be Rotated at Will About Central Pivot.

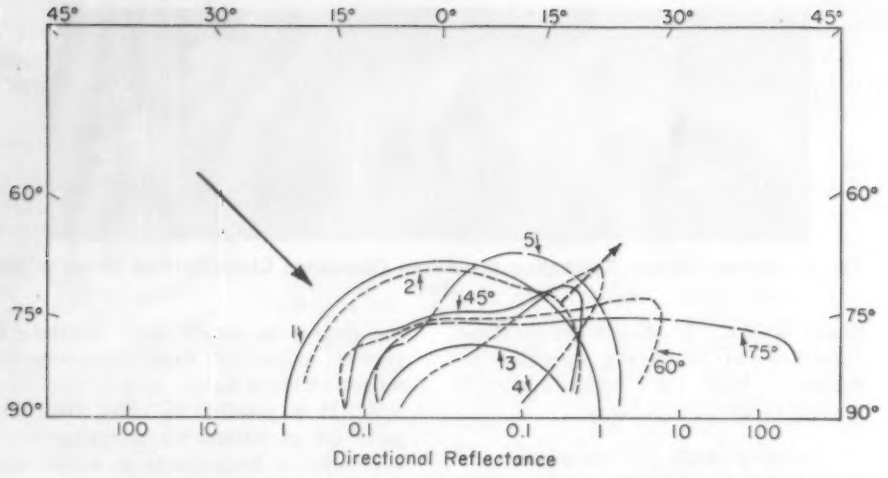


Fig. 5.—Goniophotometric Curves of Six Typical Surfaces Illuminated at 45 Deg.

(1) white mimeograph paper, (2) white porcelain enamel, (3) low-gloss, olive-drab paint, (4) medium-gloss, olive-drab paint, (5) aluminum paint; and goniophotometric curves of a green, semigloss paint for three incidence angles: 45, 60, and 75 deg.

by R. W. Wood, and Jenkins and White. For unpolarized incident light and nonmetallic materials, for which $\kappa = 0$, the relation between specular reflectance, R_s, i, and n is:

$$R_s = \frac{1}{2}\left\{\frac{\sin^2(i-r)}{\sin^2(i+r)} + \frac{\tan^2(i-r)}{\tan^2(i+r)}\right\}$$

where r is the angle of refraction

$$r = \sin^{-1}\frac{\sin i}{n}$$

In Fig. 3, R_s is plotted as a function of i for a nonmetallic mirror (like black glass) for which $n = 1.530$.

The surfaces of materials met in practice vary from glassy smooth to granular and wavy, with a variety of different textures. Surface departures from planeness only one fourth the wavelength of light are large enough to cause diminution and diversion of specularly reflected light. Dimensionwise, the smallest surface roughness which interferes with gloss is thus of the order of 0.1μ, or 4 microinches. It can be appreciated that, as specimens differ in refractive index and structure, their powers to distribute reflected light will vary widely. The exact manner in which an area of surface reflects the light of a given incident beam is determined by a complicated set of factors involving its structure and composition.

The geometric manner in which incident light is reflected in different directions is measured with a goniophotometer and represented by a goniophotometric curve of directional reflectance plotted against direction of view. A goniophotometer (Fig. 4) is an instrument with which reflected or transmitted light can be measured as the directions of the illuminating and viewing beams are varied. In the instrument in the figure, source of light and specimen may be rotated separately about the central vertical pivot.

The readings of a goniophotometer are converted to values of directional reflectance and then plotted against angle of view. Polar coordinate paper may be used for these graphs with direction plotted as angle, and directional reflectance plotted radially on a logarithmic scale. When the specimen forms mirror images, its specular reflectance is properly represented by a vector in the direction of mirror reflection because this image-forming reflected light undergoes no diffusion. An idealized goniophotometric curve is shown in Fig. 1. Goniophotometric curves of actual specimens are shown in Fig. 5.

The curves shown in Fig. 5 are those of:

1. The ideal matte white
2. A white porcelain enamel surface with high gloss.
3. A dark, low-gloss, olive-drab paint.
4. A medium-gloss, olive-drab paint.
5. A panel coated with aluminum paint.

Also shown in Fig. 5 are curves representing the same green semigloss paint illuminated from three directions (45, 60, and 75 deg). It will be noted that as the direction of illumination approaches grazing, the brightness of the specimen in the direction of mirror reflection increases markedly. This characteristic of nonmetallic surfaces to increase in shininess with angle of reflection is familiar to everyone and results directly from the above-mentioned Fresnel relation between specular reflectance and angle of incidence. Because of this characteristic, it may be concluded that low-gloss materials are best compared for gloss at high angles of incidence, high-gloss materials at low angles.

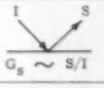
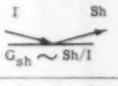
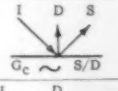
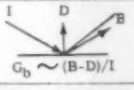
In some surfaces one finds variations in geometric distribution of reflected light with orientation as well as with direction of the incident light. Surfaces of woven cloths and other materials with criss-cross patterns are represented by goniophotometric curves that vary with orientation of markings or weave as well as with the direction of the incident light. There are thus a variety of physical features which affect the geometric manners in which surfaces of objects reflect the light that is incident upon them.

Types of Gloss-Rating Scales

If one studies the manners in which different materials are visually rated for glossiness, he finds that the physically complex picture presented by the great variety of goniophotometric curves has its counterpart in a variety of appearance criteria used in visual ratings of glossiness. Each technologist dealing with a material where gloss is important is like the paint chemist quoted above. His primary interest is in a

Fig. 6.—Two Ceramic Bowls Exhibiting a Difference in Shininess, or Specular Gloss.

TABLE II.—TABULATION OF SIX APPEARANCE CRITERIA FOR GLOSS.

Type of Gloss	Perceptual (Appearance) Criterion	Reflectance Function	Classes of Surfaces Involved
Specular gloss.....	Shininess, brilliance of highlights		Medium-gloss surfaces of paint, plastics, etc.
Sheen.....	Shininess at grazing angles		Low-gloss surfaces of paint, paper, etc.
Contrast gloss.....	Contrast between specularly reflecting areas and other areas		Low-gloss surfaces of paint, textile cloth, etc.
Absence-of-bloom-gloss.....	Absence of haze, or milky appearance adjacent to reflected highlights		High- and semigloss surfaces in which reflected highlights may be seen
Distinctness-of-image gloss.....	The distinctness and sharpness of mirror images	Not yet measured as function of reflectance	High-gloss surfaces in which mirror images may be seen
Surface-uniformity gloss.....	Surface uniformity, freedom from visible nonuniformities	Not function of reflectance	Medium-to-high-gloss surfaces of all types

gloss-measurement scale that will provide numbers for his specimens that correlate with the glossiness ratings given them by technologists like himself who regularly work with the material.

An experience in 1935 first suggested to the author the potential complexity of the gloss-measurement problem. In 1934, a 45-deg specular glossmeter had been developed and successfully applied to a number of types of paint, paper, and plastic surfaces (**8**). However, this instrument was not successful with a series of white porcelain-enameled panels exhibiting important, readily discernible gloss differences. That is, gloss values measured with the instrument did not correlate with visual rankings. Two of these panels are shown in Fig. 10 where it can be seen that the feature which distinguishes between them is the sharpness, or distinctness of mirror images. This narrow-angle, image-reflecting capacity was not what the 45-deg glossmeter measured.

During the years 1935 to 1937, many different materials and their glossiness rankings were studied by the author. From these studies it was concluded that there exist at least six different visual criteria by which glossiness rankings are made. It was assumed that correspondingly there are at least six completely different procedures for making useful measurements of gloss and these were accordingly called "six types of gloss." These were identified by means of a table similar to Table II.

This general type of table was first used in the 1937 Hunter paper (**9**), but it subsequently appeared in the 1939 Hunter and Judd paper (**10**) and many other publications. In it are: (1) names of each of the "six types of gloss," (2) the glossiness (appearance) criterion associated with each, (3) the reflectance function applicable to its measurement, (4) the classes of surfaces generally involved. Since 1936, this table has successfully classified many gloss ranking procedures and pointed the way to testing many different materials. To use it, one determines for any glossiness difference, which of the six criteria is visually most apparent.

Figures 6, 7, 8, 9, 10, and 11 were made for the author at the Color Control Department of the Eastman Kodak Co. to show some of the various appearance differences that affect visual ratings of gloss. Figure 6 shows a simple difference in shininess which is readily revealed in the curved surfaces of the ceramic bowls. Figure 7 shows a typical difference in luster (as it is usually called in the textile field) between two white rayons. Note here that the visual evidence of luster appears in the contrast between highlight reflecting areas and the adjacent darker areas of the surfaces. The darkening of the glossy surface beside each highlight is probably more important in revealing luster than is the highlight itself. This glossiness criterion has been called contrast gloss.

Figure 8 shows two plastic wall tiles in which are reflected the image of a gridiron pattern. The difference between these tiles is of a type commonly called bloom or reflection haze. Like contrast gloss in the previous figure, desirable surfaces without bloom are characterized by dark areas adjacent to bright highlights. Thus contrast gloss and absence-of-bloom gloss are

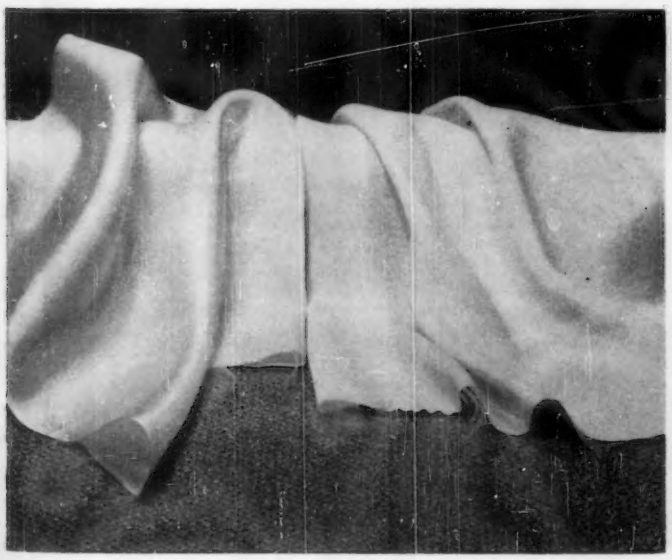


Fig. 7.—Two White Rayon Taffetas Exhibiting a Difference in Contrast Gloss.

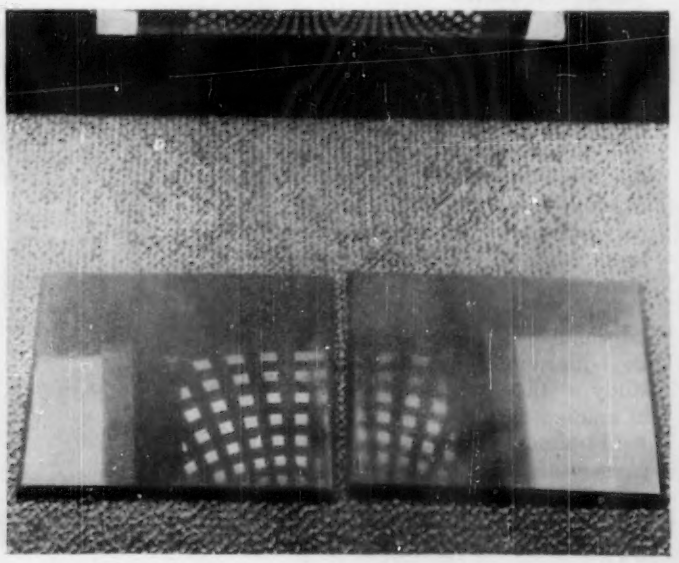


Fig. 8.—Two Blue Plastic Wall Tile Exhibiting a Difference in Reflection Haze, or Bloom.

Fig. 9.—Two Furniture Finishes Showing a Difference in Distinctness-of-Reflected-Image Gloss. As noted below, both have good depth of finish for there is no visible surface texture.

alike except that one usually applies the term bloom only when surfaces are glossy enough to reflect distinct images. Bloom imparts a characteristic milky appearance to those areas of surface adjacent to reflected highlights. It is more easily seen when surfaces are dark or colored since bloom dilutes color.

Figures 9, 10, and 11 depict differences in the fidelity of image reflection (distinctness-of-image gloss). Figure 9 shows two flat, furniture-finish panels. Figure 10 shows the two porcelain enamel panels which were mentioned above.

Figure 11 shows two chromium-plated bumper bars that differ importantly in their capacity to reflect mirror images. At the present time there are no optical glossmeters which will measure curved surfaces for differences of the type shown. Commercially these differences are quite important for they correlate closely with the amount of hand labor expended in buffing the specimens prior to plating.

There is nothing final about six as the number of criteria associated with the dimensions of gloss. A careful study of the practices of technologists in grading a wide variety of materials would almost certainly lead to an expansion of Table II.

In Table II, only the first four gloss criteria refer to quantities subject to measurement as geometric functions of reflectance. It is proper to consider the fifth perceptual attribute, mirror fidelity, as a function of geometric reflectance. In practice, however, it is very difficult to measure mirror fidelity photometrically. This is because the human eye has a higher resolving power than do practical reflectance measuring instruments. Actually, the normal human eye can see two lines as separate when they subtend an angle of roughly 0.01 deg. With photometric measurements of reflectance, on the other hand, it is generally impractical to limit receptor field angles to even 100 times this figure (1 deg in width). This is because requirements for test-surface flatness and reflectance instrument alignment are too high for practical attainment.

The problem of obtaining test surfaces sufficiently flat for narrow-angle measurements of high gloss is rendered even more difficult by the fact that, in an instrument, it is not possible to differentiate between loss of specular-beam light flux due to poor image-reflecting quality and loss of flux due to surface curvature. The eye can readily distinguish between these two effects. Images seen by reflection in nonflat surfaces are merely distorted in size and shape, not diffused as by a surface that is microscopically rough. The photometric instrument has no such power of discrimination. Consequently, perfectly flat surfaces are required for specular-reflectance measurements of high gloss.

Since photographic methods have the necessary resolving power, it has been suggested (14) that photographs of reflected images be used as records of distinctness-of-reflected-image gloss. Slator (17) has suggested that photographic methods be similarly used for obtaining goniophotometric data. If Slator's apparatus were refined and perhaps modified to provide a high angular resolving power when required,

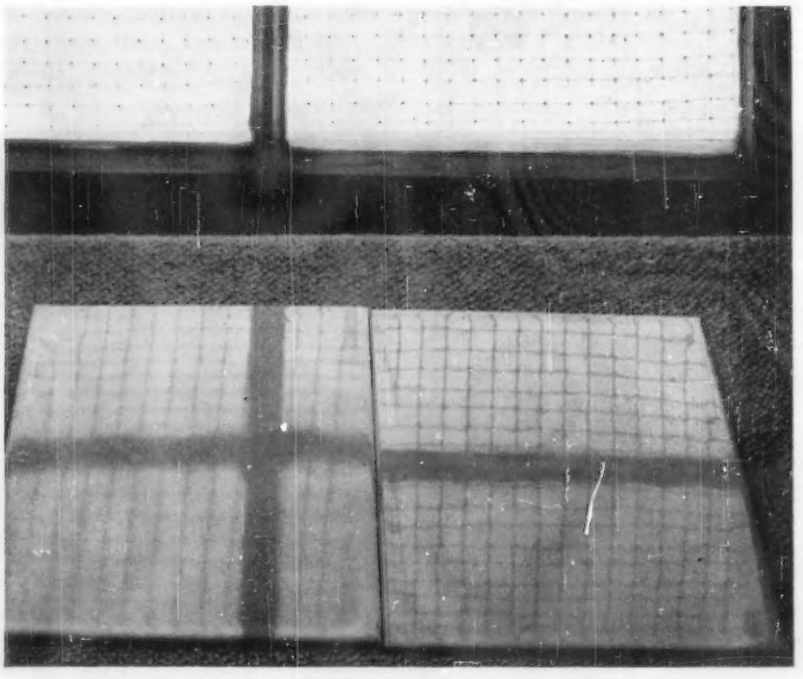


Fig. 10.—Two White Porcelain Enamels Exhibiting a Difference in Distinctness-of-Reflected-Image Gloss.

it might find considerable application. Luck and Archibald (14) have also made effective use of photography in gloss studies of image forming surfaces.

Visible surface texture is not a function of the capacity of a unit area of a specimen to reflect light in different directions. Therefore, it is questionable whether it is proper to call "absence of surface texture" an attribute of gloss. A study of commercial practice in the gloss grading of a number of different materials reveals, however, many instances in which graders permit the visible textures of surfaces to affect their judgments of gloss.

Because texture makes position of surface more visible, "depth of finish" can be thought of as "absence of surface texture." A surface has "depth of finish" when the observer does not readily see any of the clues by which he ordinarily recognizes the existence of surfaces, (that is waviness, granularity, dirt, smears, scratches, markings, dust particles, etc.). Depth of finish is closely associated with the evenness, levelness, and cleanness of surfaces. It would require, for measurement, some determination of the ease with which the normal eye can resolve or recognize surface position without the normal clues of object shape and position. Both the surfaces of Fig. 9 have good depth for they show no texture, dirt, smears, or markings. Any test of depth must obviously be more subjective than is a measurement of reflected light. There is no apparent way to measure it by routine psychophysical procedures.

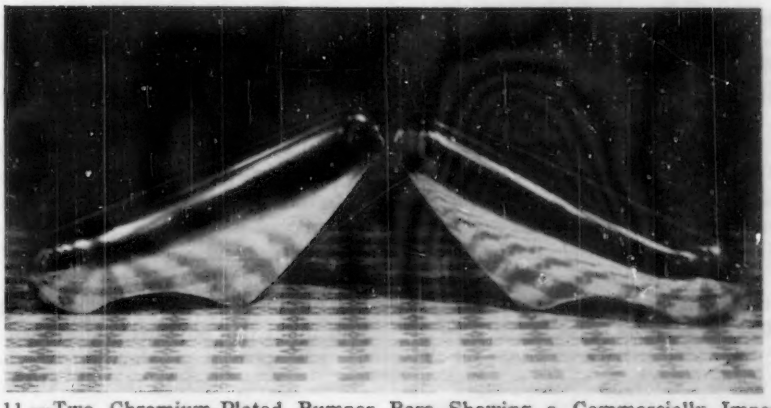


Fig. 11.—Two Chromium-Plated Bumper Bars Showing a Commercially Important Difference in Distinctness-of-Reflected-Image Gloss.

Established Methods of Gloss Measurement

There is variety in the established methods of gloss measurement for two reasons:

1. As shown in the foregoing paragraphs, it is necessary to measure different aspects of reflectance in order to duplicate different gloss grading procedures.

2. Even where the same aspect of reflectance (for instance, specular gloss) may be used to grade two types of materials, the photometric conditions best for differentiating specimens of one type may differ from those which are best for the other.

Table III lists six established methods of gloss test, the major applications of each, the specification numbers and designations by which each is known, the angular conditions of measurement, the basis for the numerical scale, and the values given on each scale to polished black glass and to the ideal, perfectly diffusing white. Values in this last column were computed from an equation given by Hammond and Nimeroff (5).

Figure 12 is a graph designed to illustrate roughly the differences between values of gloss measured on five of the six scales in Table III. The ordinates are numerical values of gloss. Equally spaced across the top of this

TABLE III.—ESTABLISHED METHODS OF GLOSS MEASUREMENT.

Angle and Name	Applications	Applicable Specifications	Field Angles, deg (First angle given is in plane of measurement)		Numerical Scale	Important Values	
			Source	Receptor		Polished Black Glass $n = 1.54$	Perfect White (dif. cor. factor)
60 deg ASTM Method D 523	Classify paints, plastics, etc., as high, medium, low, or intermediate in gloss. Measure gloss differences in all gloss ranges but high and very low	ASTM Method D 523 – 51 T Method 610.1 of Federal Specification TT-P-141b	1 × 4 (maxima)	4.4 × 11.7	G_s, perfect mirror = 1000	96	2.5
57½ deg Ingersoll Glarimeter	Measure uncoated white papers for tendency to glare in poor light. Customs test of newsprint	TAPPI T424m-45	12 × 12 (12.6 diameter according to Ingersoll)	Very small	Contrast gloss, polarization method	100	0
75 deg Modified Oxford Method	Gloss of coated, waxes and glassine papers, printed cartons, etc.	TAPPI T480m-51	2.8 × 5.7 (maxima)	11.4 diam	G_s, black glass (n = 1.54) = 100	100	1.0
85 deg	Sheen (shininess at grazing angles) of flat matte paints, camouflage coatings, and other surfaces	Method 611.1 of Federal specification	1 × 2	4 × 6	G_s, black glass (n = 1.532) = 100	100+	0.03
45 deg PEI gloss	Evaluation of acid and abrasion resistance of porcelain enamels	PEI Bulletins T-2 and T-7	1.4 × 3.0	8.0 × 10.0	G_s, perfect mirror = 100	5.6	0.53
20 deg High-gloss test	Measure gloss differences of high-gloss enamels and other shiny surfaces (test surfaces must be flat)	Under development	1.0 × 1.8	2.8 × 3.3	G_s, black glass (n = 1.54) = 100	100	1.8

table are the names of the five gloss classes for which gloss value limits are given in ASTM Method D 523.[3] A smooth curve was drawn through the limit values for each class below 70. This smooth curve was then permitted to fix the abscissa for each of the variety of paint, paper, and plastic specimens measured by the five different methods. Readings for each specimen from the four other glossmeters are plotted directly above or below the corresponding 60-deg reading. From this technique, a smooth curve is obtained for the 60-deg test since it is used as reference. Broad bands within which most values fell were obtained for the other measurement methods.

For the high-gloss range, the 60-deg method does not provide suitable differentiation; therefore a smooth curve was arbitarily drawn for the 20-deg high-gloss method. Bands were then drawn for the other methods. Note that through much of the gloss range the 75-deg test method gives values higher than the 85-deg sheen method. On the basis of incidence angle, the opposite would be expected. From the fifth column in Table III, however, it can be seen that the receptor angle of the 85-deg sheen method is much smaller than that of the 75 deg gloss test. Because of this small window, the 85-deg sheen method gives numerically small values.

ASTM Method D 523, Method 610.1 of Federal Specification TT-P-141b (4):

This test method developed as a result of work in ASTM Committee D-1 on Paint, Varnish, Lacquer and Related Products dating back to 1933 and before. During the 1930's, panels were obtained by the group working on this project from a number of paint laboratories in response to requests for typical finishes in each of three gloss ranges: high gloss, eggshell, and flat. The group set as its task the development of the best measurement method for separating these panels into their respective gloss classes.

The late A. H. Pfund worked on the panels at Johns Hopkins University. Hunter and Judd measured them at the National Bureau of Standards. Different specular angles were used, and Hunter and Judd tried different field angles. Both sets of investigators concluded that specular measurements at 60 deg were best for separating the paint panels into their different classes. The geometric conditions found best during these investigations are those now specified in the standard 60-deg test methods. The final report on this project (10) shows that the test procedure which they then offered, and which subsequently became ASTM Method D 523, could be used for two purposes: (1) to classify paints as either high-gloss, eggshell, matte, or intermediate, and (2) to measure small differences in gloss between surfaces of like texture and color in all but the high-gloss and matte ranges.

The method developed by Hunter and Judd has enjoyed widespread use. It has proved applicable to plastic films, waxes, certain metals, and other materials, as well as to paints. The numerical scale of this method is widely known and used. Nevertheless, it is important to recognize that the 60-deg method is designed to separate high- and low-gloss specimens from those possessing intermediate shininess. The method is most sensitive in the middle-gloss range and is relatively insensitive to visible differences of both high and low shininess.

The 85-deg sheen method to be described presently has proved suitable for many low-gloss measurement problems and the 20-deg high-gloss test method (still under development) is being tried for the measurement of small differences at the opposite end of the scale.

57½ deg Ingersoll Glarimeter Test for Paper:[4]

The Ingersoll Glarimeter (12) was developed about 1915 and is not only the oldest glossmeter made commercially, but the first to be employed on an industry-wide basis. It is essentially a contrast-gloss instrument measuring the specular component of reflectance in terms of specular plus diffuse (rather than the specular alone as with the other four tests represented in Fig. 12).

Light specularly reflected at 57½ deg from a nonmetal is completely polarized if the refractive index is 1.54. The Ingersoll Glarimeter merely compares at 57½ deg the light polarized in one plane with that polarized in another. Because it is a contrast-gloss method, the test is suitable only for white and light-colored surfaces.

75-deg Gloss—TAPPI Method T 480 m-51:[5]

This test method is sometimes known as the "Modified Oxford Glarimeter" because the first glossmeter of this type was built at the Oxford Paper Co. The

[4] TAPPI Method T424m-45, Contrast Gloss of Paper at 57.5°, *Tappi*, Vol. 34, No. 2 86A (February, 1951).

[5] TAPPI Method T480m-51, Specular Gloss of Paper at 75°, *Tappi*, Vol. 34, No. 2, 87A (February, 1951).

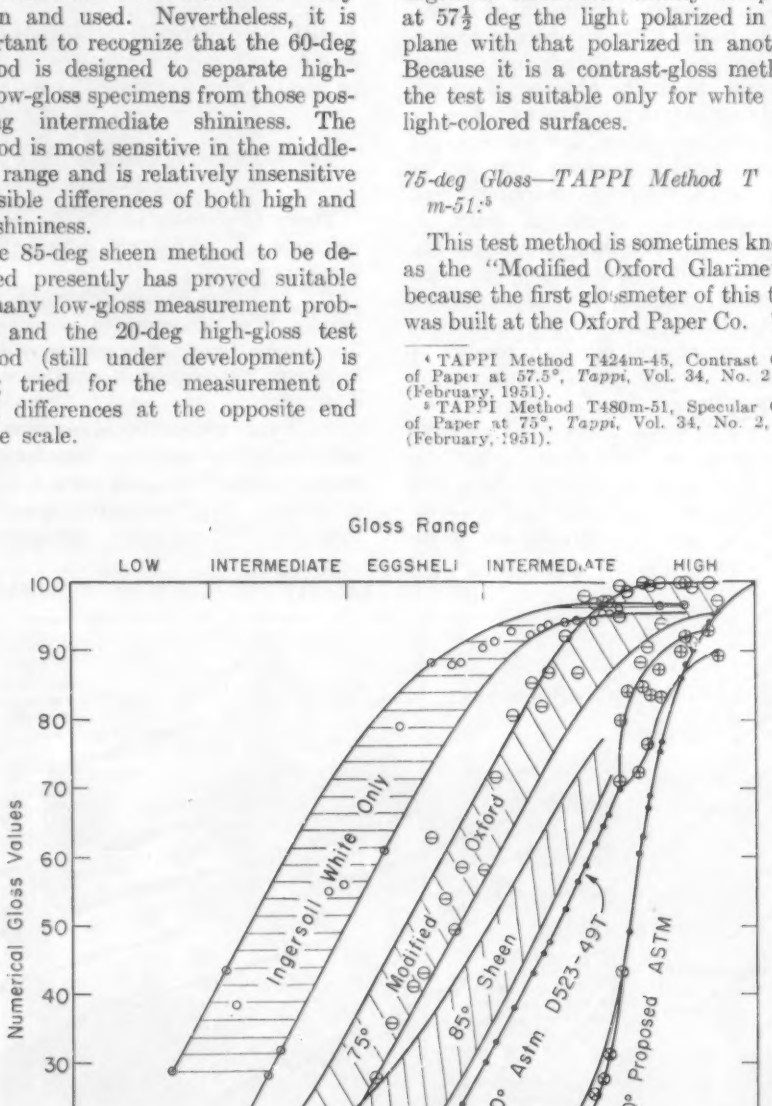


Fig. 12.—Qualitative Differences Between Established Gloss Scales.

Abscissa intended to show visually-uniform spacings of gloss from low to high. Actually, the 60 deg reading was used to locate abscissa of each specimen below high-gloss; the 20 deg reading was similarly used in the high-gloss range.

[3] Standard Method of Test for 60-Deg Specular Gloss (D 523 – 51), 1951 Supplement to 1949 Book of ASTM Standards, Part 4, p. 69.

major work in standardizing the device was done at the Institute of Paper Chemistry, where the instrument was modified to give results correlating with visual estimate of gloss supplied by paper technologists (13). The papers used for the standardization method were coated and uncoated book papers. The test is thus primarily designed for the gloss differentiation of white book papers. However, in practice it has proved useful for the gloss comparison of waxed papers, glassine papers, and printed areas of paper where there is interest in the gloss of ink.

85-deg Sheen—Method 611.1 of Federal Specification TT-P-141b. (3):

This method was developed by J. W. Ayers of the C. K. Williams Co. (1) and was subsequently employed during the past war to test matte camouflage finishes used by the Ordnance Department. The method subsequently appeared in Federal Specification TT-P-141b and is now being applied quite generally to measurements of interior flat wall paints, as well as to camouflage finishes. A group of ASTM Committee D-1 is currently writing a method for the same test.

45-deg Gloss—PEI Bulletins T-2 and T-7 (16):

The author's Multipurpose Reflectometer (11) was initially developed in 1936 for use in the Porcelain Enamel Institute tests of reflectance and loss of gloss due to abrasion and acid attack of porcelain enamels. These tests were developed at the National Bureau of Standards. It seemed advantageous to have a single instrument available for the various photometric tests developed for use with porcelain enamels. Specular-gloss measurements at 45 deg with the Multipurpose Reflectometer, which also measures 45 deg 0 deg directional reflectance, proved suitable for determinations of acid and abrasion attack of porcelain enamel surfaces. It has been learned since its design in 1936 that the Multipurpose Reflectometer is not a particularly reproducible glossmeter because of vignetting suffered by the gloss beam as it passes through the several windows between specimen and receptor photocell. The 45-deg geometric conditions of measurement given in Table III were selected as representative of those of the Multipurpose Reflectometer and have been incorporated into newly developed glossmeters which are free from vignetting.

20-deg High-Gloss Test (Experimental):

This method was developed by Horning and Morse (7) at the Marshall Laboratory of E. I. du Pont de Nemours & Co., Inc., Philadelphia, Pa. Its major use in this laboratory has been to rate high-gloss, alkyd-type enamels for gloss. Because high-gloss surfaces reflect fairly good images, it is essential that a narrow receptor window be used in this high-gloss test. It is also necessary that test surfaces be flat. For tests of paints, draw-downs are made on plate glass to obtain the necessary specimen flatness. The new test method is probably applicable to high-gloss surfaces of non paint, as well as paint materials.

Summary

The average materials technologist decries the present growth of a variety of gloss testing procedures. It must be admitted that in the past there has been little coordination as the various gloss test methods now in use were developed in laboratories dealing with different materials. Effective coordination of the needs of different technologies might reduce slightly the present number of established gloss testing procedures.

However, the geometric reflectances of different object surfaces vary greatly from one to another, and the corresponding appearance features used for visual ratings of gloss differ greatly. No single gloss-measurement procedure will ever serve all the needs of materials technology. There are at present no established measurement procedures for several of the appearance criteria used for visual ratings of gloss. New gloss testing procedures are needed for these criteria which at present cannot be measured. Therefore the net trend in glossimetry will probably be toward more rather than fewer gloss testing procedures.

References

(1) J. W. Ayers in conjunction with New England Paint & Varnish Production Club, "Inert Pigments and Their Effects in Flat Paints," *Scien. Sect. Circ.* No. 568, Nat. Paint, Varnish and Lacquer Assn., Washington, D. C., November, 1938, p. 109.

(2) G. S. Buck, Jr., and F. A. McCord, "Luster and Cotton," *Textile Research Journal*, Vol. 19, No. 11, (November, 1949). Reprinted under separate cover by Nat. Cot. Counc. Am.

(3) Federal Standard Stock Catalog, Procurement Division, Washington, D. C., Federal Specification TT-P-141b for Paint, Varnish, Lacquer, and related materials; Method of Inspection, Sampling and Testing (January 15, 1949).

(4) A. Fresnel, "Calcul des teintes que polarisation developpe dans lames cristallisees," *Ann. Chim. phys.*, Vol. 17, pp. 194, 312, (1821). Moon has recently published a table of Fresnel reflections (see Parry Moon, "Table of Fresnel Reflection," *Jour. Math. Phys.*, Vol. 19, pp. 1–11 (1940)). This table, however, is not ideally suited for finding specular gloss because the large interval of refractive index (0.1) and the use of radians to express the angle (i) make the interpolation, which is necessary to its use for this purpose, inconvenient.

(5) H. K. Hammond, III, and I. Nimeroff, "Measurement of Sixty-Degree Specular Gloss," *Journal of Research*, Nat. Bur. Standards, Vol. 44, p. 585 June, 1950, *RP* 2105.

(6) V. G. W. Harrison, "Definition and Measurement of Gloss," W. Heffer and Sons, Ltd., Cambridge, England (1945).

(7) S. C. Horning and M. P. Morse, "The Measurement of Gloss of Paint Panels," *Official Digest*, Fed. of Paint and Varnish Production Clubs, p. 153, March, 1947.

(8) R. S. Hunter, "The Glossmeter," Scien. Sect. Circ. No. 456 of the Nat. Paint, Varnish and Lacquer Assn., April, 1934.

(9) R. S. Hunter, "Methods of Determining Gloss," *Journal Research*, Nat. Bur. Standards, Vol. 18, p. 19, January, 1937, *RP* 958; *Proceedings*, Am. Soc. Testing Mats., Vol. 36, Part II, p. 783 (1936).

(10) R. S. Hunter and D. B. Judd, "Development of a Method of Classifying Paints According to Gloss," ASTM Bulletin No. 97, March, 1939, p. 11.

(11) R. S. Hunter, "A Multipurpose Photoelectric Reflectometer," *Journal of Research*, Nat. Bur. Standards, Vol. 25, 581, 1940 *RP* 1345; also *Journal*, Optical Soc. Am., Vol. 30, November, 1940, p. 536.

(12) R. S. Ingersoll, "The Glarimeter—An Instrument for Measuring the Gloss of Paper," *Journal*, Optical Soc. Am., Vol. 5, p. 213 (1921); see also *Electrical World*, Vol. 64, p. 35 (1915).

(13) Institute of Paper Chemistry, "Instrumentation Studies V. Report on Gloss," *Paper Trade Journal*, Vol. 104, No. 1, January 7, 1937, p. 42; Institute of Paper Chemistry, "Instrumentation Studies VI. The Modified Oxford Glarimeter," *Paper Trade Journal*, Vol. 104, No. 2, January 14, 1937, p. 42.

(14) H. R. Luck and R. C. Archibald, "The Photography of Surface Details of Glossy Panels," presented at the Symposium on Varnish and Paint Chemistry, N. Y. Univ. (undated).

(15) H. J. McNicholas, "Absolute Methods in Reflectometry, *Journal of Research*, Nat. Bur. Standards, Vol. 1, p. 29 (1928) *RP* 3.

(16) PEI Bulletin T-2, "Test for Resistance of Porcelain Enamels to Surface Abrasion," PEI Bulletin T-7, "Test for Acid Resistance of Porcelain Enamels," Part 1—Flatware, Porcelain Enamel Institute, Inc., Washington, D. C.

(17) J. M. Slator, "A Recording Goniophotometer," *Journal*, Optical Soc. Am., Vol. 25, 218 (July 1935).

(18) D. Smith, "Problems in Gloss Evaluation," *Interchemical Review*, Vol. 7, p. 95 (1948–49).

(19) L. A. Wetlaufer and W. E. Scott, "The Measurement of Gloss," Ind. and Eng. Chemistry, Anal. Ed., Vol. 12, p. 647 (1940). See also Bull. No. 2115 of the American Instrument Co. (Silver Spring, Md.) "Aminco-Scott Glossmeter," May, 1943.

The Effect of Temperature and Composition Upon the Resilience of Elastomers

By E. F. Schulz[1]

SYNOPSIS

The Bashore Resiliometer has been used successfully to measure the resilience of elastomers at temperatures ranging from 0 to 170 C. Such test results are insensitive to sample geometry or finish, are independent of operator effects, and are of good reproducibility. The resilience of elastomers is highly dependent upon temperature. The resilience *versus* temperature curves for plasticized polyvinyl chloride resins are characterized by pronounced maxima and minima. These curves are dependent upon the composition; they are influenced by plasticizer type and concentration, and by filler content.

WHEN an elastomeric body is subjected to and relieved of a sudden deformation, a portion of the energy of deformation is immediately recoverable and the remainder dissipated in damping or hysteresis losses. Resilience has been defined (1)[2] as the percentage of the recovered energy to the energy required to produce the deformation. As used here, resilience is a measure of the immediately recoverable energy, and thus does not take into account creep, delayed elastic, and other time-dependent effects.

The resilience characteristics of synthetic elastomers are of importance in many applications such as gasketing vibration dampers, and in many cases where plastics replace natural rubber. Measurement of this property, over an extended temperature range and preferably by a simple method, is becoming increasingly important. In many design considerations, the availability of such data is an engineering necessity.

TEST APPARATUS AND PROCEDURE

Various resilience measuring devices, as well as the general subject of resilience, have been treated in numerous publications (1). From the several available techniques, the rebound resiliometer, developed by Bashore (2) was used. This is an inexpensive, portable instrument of simple consruction and operation, which measures the rebound of an essentially freely falling weight.

A sketch of the resiliometer is shown in Fig. 1. Resilience is measured by observing the height to which the 1-oz plunger will rebound when dropped on the specimen from a height of 16 in. The operator observes the number immediately behind the top of the weight at the peak of rebound. The first three readings are disregarded, and the average of the five following reported as the resilience reading.

Measurements between 0 and 60 C were made in available controlled temperature rooms after overnight conditioning of sample and tester. At temperatures above 60 C, the resiliometer was installed in a circulating air oven provided with a glass inner door. A remote control triggering and resetting mechanism was used to actuate the plunger externally without disturbing the temperature equilibrium in the oven. Specimen temperature was measured with a thermocouple embedded between sheets of the specimen stack. This provided a continuous means for following the temperature rise and permits stabilization at the desired level.

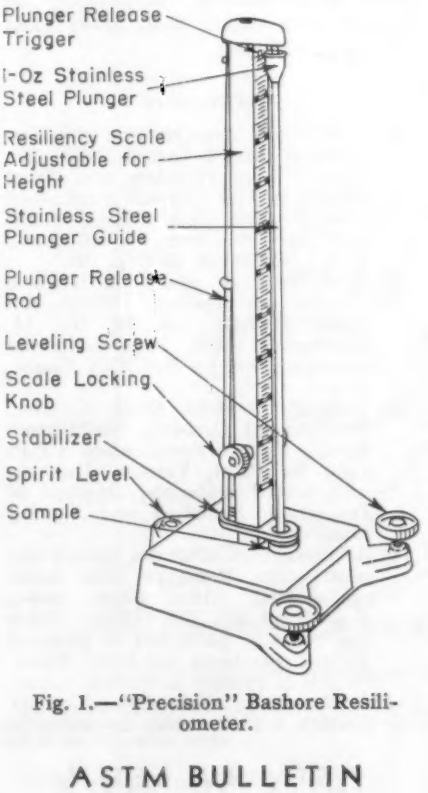


Fig. 1.—"Precision" Bashore Resiliometer.

TEST VARIABLES

Davis and Blake (3) caution against the influence of specimen geometry, age, surface, and other factors upon resiliometer test results when testing rubbers. The effect of these and other possible variables upon resilience measurements of plasticized vinyls was investigated. Most of the investigations were conducted on three concentrations of dioctyl phthalate plasticizer (DOP) compounded with vinyl chloride-vinyl chloride acetate copolymer resin (VYNW). The 25, 35, and 45 per cent plasticizer concentrations have been designated as compounds A, B, and C, respectively.

Various thicknesses of samples were tested with the results shown in Table I. Although initially an increase in rebound is observed with increasing thickness, the data become essentially independent of specimen thickness at 0.5 in. This thickness was, therefore, used throughout this work and is the recommended minimum for all measurements. These results parallel Bashore's findings for pure gum rubber (2). Test results were also found to be independent of specimen diameters ranging between 1 and 2 in. This will be seen from Table II. For reasons of convenience and standardization, 1.5-in. diameter specimens were used.

It is generally not convenient to mold specimens in ½-in. thicknesses. Consequently, disks of thin sheeting were

TABLE I.—EFFECT OF SAMPLE THICKNESS UPON REBOUND.

Thickness, in.	Rebound at 25 C, per cent		
	Compound A	Compound B	Compound C
0.083..	21	...	...
0.165..	25	...	...
0.248..	28	...	...
0.252..	...	11	...
0.268..	...	...	12
0.330..	28	...	...
0.335..	...	11	13
0.402..	...	...	14
0.413..	27	...	...
0.420..	...	12	...
0.469..	...	...	14
0.495..	26	...	...
0.504..	...	11	...
0.536..	...	...	15

TABLE II.—EFFECT OF SPECIMEN DIAMETER.

	Rebound at 25 C, per cent		
	1 in. Diam	1.5 in. Diam	2.0 in. Diam
Compound A..	30	29	27
Compound B..	12	11	12
Compound C..	13	13	13

[1] Development Department, Bakelite Co., a division of Union Carbide and Carbon Corp., Bound Brook, N. J.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

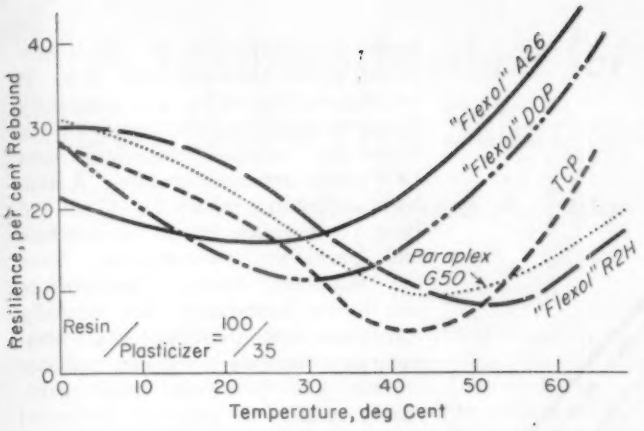


Fig. 2.—Temperature-Resilience Characteristics of Various Plasticizers with VYNW Resin.

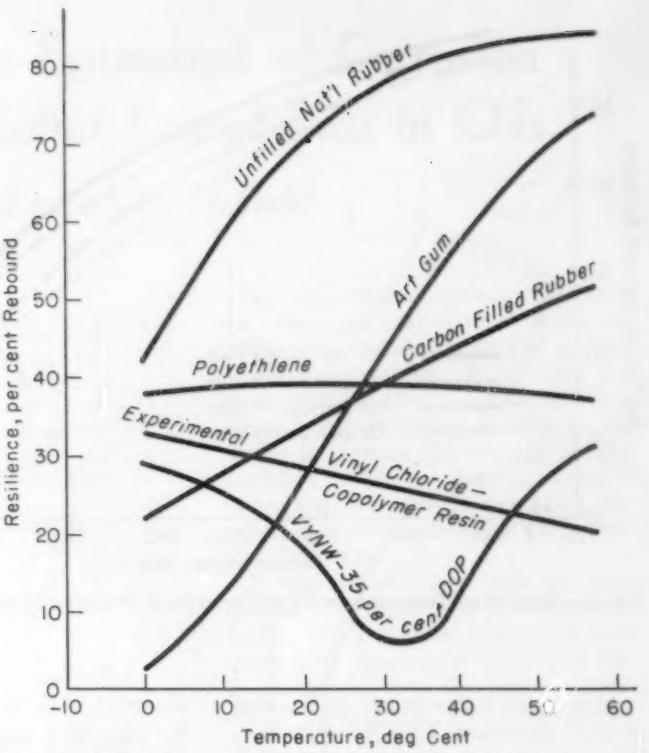


Fig. 3.—Temperature-Resilience Characteristics of Various Elastomers.

superimposed to ½-in. thickness and test results compared to data obtained on a single disk of the same thickness. Such a comparison is shown in Table III. Good agreement exists between the two types of specimens. Solid or composite specimens can, therefore, be used interchangeably.

TABLE III.—COMPARISON OF REBOUND RESULTS, COMPOSITE *VERSUS* SOLID SAMPLES.

	Average per cent Rebound at 25 C, 0.5 in. Thickness		
	Compound A	Compound B	Compound C
Composite	29	12	13
Solid	27	11	13

Possible effects due to type of sample finish have been suggested by Hemmler (**4**). Comparative tests between press polished and matte finished samples, however, did not exhibit any significant difference. Comparative data for plasticized vinyls are shown in Table IV.

TABLE IV.—EFFECT OF SPECIMEN FINISH UPON REBOUND.

	Rebound at 25 C, per cent	
	Press Polished	Matte
Compound A	32	31
Compound B	18	19
Compound C	16	17

Good agreement among operators was exhibited by resilience data of nine different compounds determined by five operators. A statistical analysis of these data substantiated the absence of operator effects.

An estimate of the over-all reproducibility of rebound measurements at room temperature was made from an analysis of 85 average test results. These data indicate a precision of ± 3 per cent rebound with 95 per cent certainty. The precision of stiff materials, however, generally appears to be poorer.

Cursory examination of aging effects upon resilience did not, for samples studied during the initial 17 days, show any noticeable trend.

Temperature Effects

The marked temperature sensitivity of most elastomers is demonstrated by Figs. 2 and 3. Here large changes in resilience are noted for the rubber compounds between 0 and 60 C. The polyvinyl chloride formulations exhibit pronounced and apparently characteristic resilience minima in this temperature region. The resilience behavior of the vinyls is shown dependent upon the type of plasticizer used.

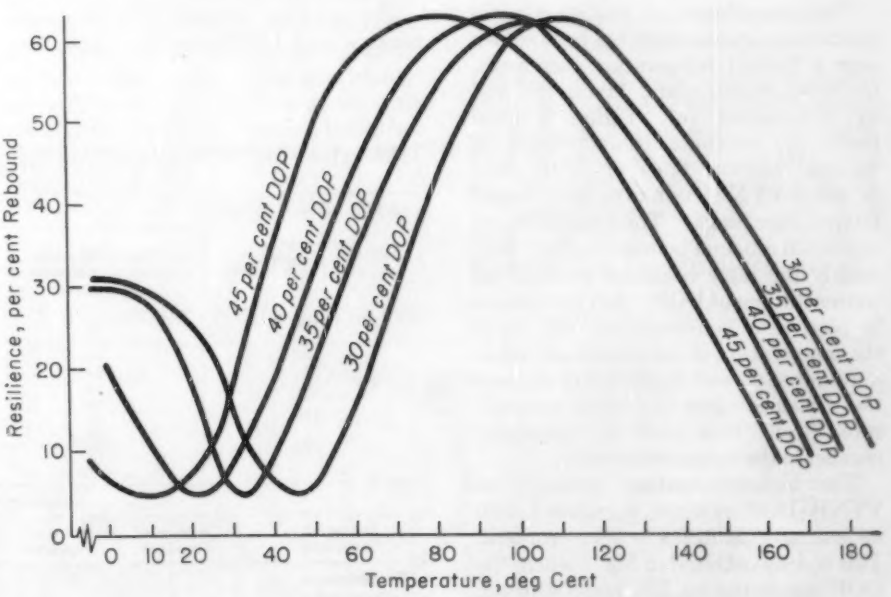


Fig. 4.—Effect of Plasticizer Concentration upon the Resilience-Temperature Characteristics of DOP Plasticized VYNW Resin.

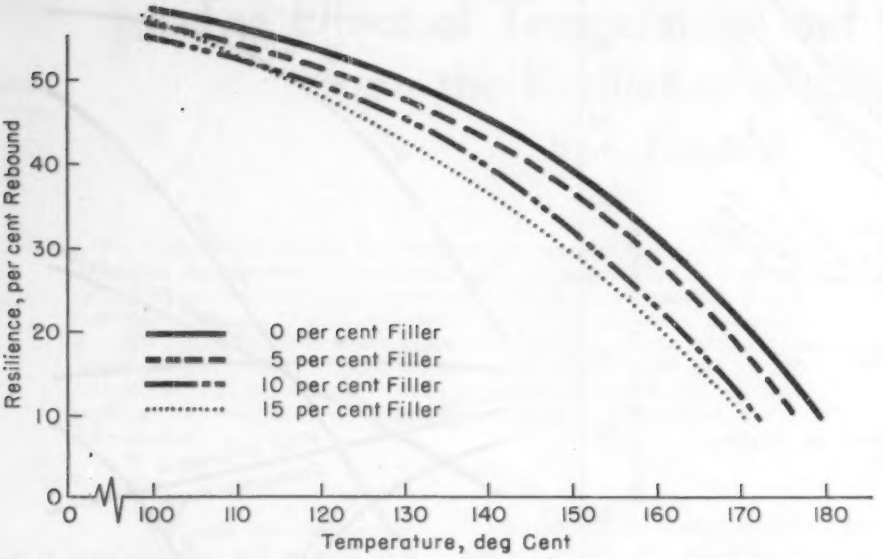


Fig. 5.—Resilience-Temperature Characteristics of Multifex ($CaCo_3$) Filled "Vinylite."

At elevated temperatures, in the case of DOP plasticized VYNW compounds, the resilience goes through a maximum and gradually decreases until at 180 C excessive softening of the specimens precludes further measurements. Thus with increasing temperature from 0 to 170 C the resilience first passes through a sharp minimum or dip, then increases more gradually to a less critical peak, and finally declines until nearly all resiliency is lost with increasing flow of the material. A family of such curves is shown in Fig. 4. The displacement of these curves is a function of sample composition.

Effect of Composition

The dependence of resilience upon plasticizer concentration has been shown over a limited temperature increment, by Rider, Sumner, and Myers (5), and by Friedlander (6). Figure 4 illustrates the resilience characteristics of various concentrations of DOP plasticizer in VYNW resin over an extended temperature range. The maximum and minimum rebound points are at approximately the same resilience level for all concentrations of DOP. But an increase in plasticizer concentration will lower the temperature of maximum and minimum rebound and in effect will displace the resilience curve to a lower temperature level. This shift is essentially parallel to the temperature axis.

The high-temperature resilience of VYNW-DOP systems is reduced with increasing "Multifex" filler content. This is demonstrated in Fig. 5 where the DOP concentration has been adjusted to give approximately the same room temperature hardness. The same characteristic decrease in resilience is observed with increasing temperature for the filled as well as the unfilled VYNW-DOP compositions in this temperature range. The rate of decrease, however, is lower for the filled material.

A resilience comparison from 100 to 170 C of several polyvinyl chloride resins and a vinyl chloride-vinyl acetate copolymer resin compounded with 35 per cent DOP is presented in Table V. The data demonstrate that statistically significant differences in resilience can be achieved by the use of different resins. However, in a practical sense these differences are small and of questionable importance and may even be attributable to minor compounding or processing variations.

The relation between the resilience minima and brittleness has been discussed by Friedlander (6) and is supported by the data presented here. It will be noted that in Fig. 4 an apparently linear relationship exists between the minimum resilience temperature and DOP plasticizer concentration. A similar relationship is reported by Clash and Berg (7) between brittle temperature and plasticizer concentration. Since the minimum resilience temperature and brittle temperature are mutually correlated with plasticizer concentration, an interrelation between resilience minima and brittleness must exist. Similar reasoning leads to a parallel conclusion between resilience minima and stiffness. Thus, a low minimum resilience temperature reflects a low embrittlement temperature and a low room temperature stiffness.

References

(1) R. F. Shaw, "A Survey of Resilience and the Development of Resilient Compounds," *India Rubber World*, September, 1948, pp. 796–802.

(2) H. H. Bashore, "A New Revised Rebound Resiliometer," *Rubber Chemistry Technology*, Vol. 10, pp. 820–826 (1937).

(3) Davis and Blake, "The Chemistry and Technology of Rubber," Reinhold Publishing Co., New York, N. Y., pp. 812–813 (1937).

(4) Hemmler, "Science of Rubber," Reinhold Publishing Co., New York, N. Y., pp. 564–577 (1934).

(5) Rider, Sumner, and Myers, "Properties of Plasticized Polyvinyl Chloride Compositions," *Industrial and Engineering Chemistry*, Vol. 41, p. 711 (1949).

(6) G. Friedlander, "Impact Resilience as a Brittleness Test for Polyvinyl Plastics," *Analytical Chemistry*, Vol. 22, pp. 1545–1551 (1950).

(7) Clash and Berg, "Stiffness and Brittleness of Non-Rigid Vinyl Chloride-Acetate Resin Compounds," *Modern Plastics*, July, 1944.

TABLE V.—TEMPERATURE-RESILIENCE CHARACTERISTICS OF VARIOUS RESINS PLASTICIZED WITH 35 PER CENT DOP.

Temperature, deg Cent.	Per Cent Rebound			
	Vinyl Chloride-Vinyl Acetate Copolymer	Polyvinyl Chloride		
		No. 1	No. 2	No. 3
100	60	58	60	58
	63	62	63	60
120	53	58	57	56
	54	55	57	55
135	48	52	52	47
	46	50	50	47
150	40	42	39	38
	39	41	39	39
170	24	27	23	19
	22	22	24	21

Analysis of Variance

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F	Probability
Temperature	3	7135	1784	649	0.001
Compound	4	49	16.3	5.94	0.01–0.001
Interaction	12	39	3.25	1.33	...
Residual	20	49	2.45	...	...
Pooled residual	32	88	2.75	...	...
Total	39	7272			

A Modified Method for the Estimation of Corrosion Due to the Free Sulfur and Sulfur Compounds in Oils

By Richard A. Patton[1] and Joseph H. Lieblich[2]

SYNOPSIS

The literature background of the ASTM Copper Strip Method[3] for estimating the corrosive nature of oils is replete with references to the interferential origin of the colors observed. Despite this fact, no comprehensive analysis of the bases for the established empirical procedure has been found. Furthermore, the several attempts to devise an acceptable, more quantitative picture have been only partially successful. Even so, where success has been achieved, the methods used have not seemed practical from a routine control viewpoint.

In this paper, the optical phenomena involved are examined in some detail in order to permit an estimation of the reliability of the present procedure of visual examination. A modified procedure is then described and an appraisal of its merit outlined. Finally a direct comparison of the two procedures is set forth.

EVER since the advent of the automobile the corrosive nature of fuels and lubricants has been a subject of considerable interest. Fortunately, for many years the petroleum stocks from which these materials were derived have been relatively noncorrosive or could be made so with little difficulty. In the past decade, though, an increasing proportion of the crude oils processed has been of a sour character. Consequently there is need for a more precise method of evaluating the corrosiveness of oils. Attesting to this fact are the revision of the ASTM Method of Test for Free and Corrosive Sulfur in Petroleum Products[3] as well as the modification described by Claxton and French (4)[4] and the proposed procedure of Matthews and Parsons (6). The Claxton and French modification, while very precise for a small degree of corrosion, presents difficulties when it is applied to even moderately corrosive materials. In a further effort to increase the utility of the test, a somewhat different approach has been used, the results of which are presented in this article. The authors have not found any published account of similar work.

The obvious impracticability of known modifications of the ASTM procedure coupled with the fact that colors and shades thereof may be precisely defined by photometric means led one of the authors to consider the feasibility of instrumentally viewing and grading stained copper strips. The availability of such instruments and the speed with which results may be obtained indicated that such a method might be practical for routine control.

The approach to the problem was actually an empirical experimental one, the immediate goal of which was a reproducible numerical system of grading corrosion specimens. It quickly became apparent that, prior to definition of any scalar quantities, it would be desirable to increase the amount of light available for the instrument to "see." Once this had been accomplished, the collection and correlation of data were straightforward.

It was not until later that the comparison with the ASTM procedure was made. Then it was discovered that there were apparently some bad discrepancies between the two methods. As a consequence, the fundamental optics were considered; and as a result of this study a comparison of the two methods became possible. It would be confusing to present the material developed in a chronological order. For this reason, a logical, topical sequence will be followed. The characteristics of the systems which determine the optical behavior will be considered first. An analysis of this optical behavior will follow. Finally, a simplification of the problem will be described and the resulting improvement will be demonstrated. Based thereon definite conclusions and recommendations can be made and are presented.

THE NATURE OF THE SYSTEMS UNDER CONSIDERATION

Constable (5) has shown that the films produced on copper by corrosive oils have the thicknesses given in Table I for the colors indicated and Matthews and Parsons (6), after giving a rather thorough discussion of the state and limitations of the use of "polished" copper strips for appraising the cor-

[1] Formerly Fellow, Mellon Institute, Pittsburgh, Pa. Present address: Geotic Industries, Inc., Akron, Ohio.

[2] Formerly of Department of Research Chemical Physics, Mellon Institute, Pittsburgh, Pa. (Now deceased.)

[3] Tentative Method of Test for Free and Corrosive Sulfur in Petroleum Products (D 130 – 50 T), 1950 Supplement to Book of ASTM Standards, Part 5, p. 172.

[4] The boldface numbers in parentheses refer to the list of references appended to this paper.

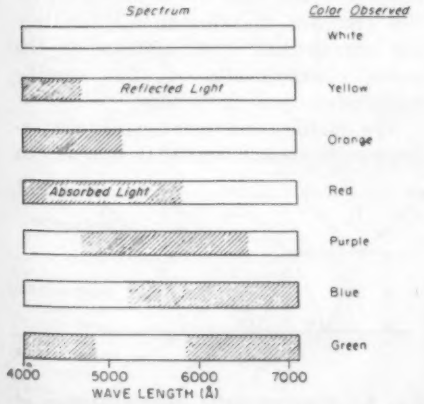


Fig. 1.—Effect of Absorption on Color Observed.

TABLE I.—COLOR, COPPER STRIP NUMBER, AND FILM THICKNESS.

Color	J. A. Bolt's Corrosion Number	Indiana Number	ASTM Method D 130 – 50 T	Film Thickness, Å
Perfect	0	0	0 No tarnish	0
Light orange	1	1	1 Slight tarnish	100
Dark orange	2	2		195
Claret red	3	3		290
Lavender	4	4		385
Silvery lavender or silver	5	5	2 Moderate tarnish	475
Brassy	6	6		565
Brassy red	7	7		655
Peacock	8	8	3 Dark tarnish	740
Transparent black	9	9	4 Slight corrosion	830
Graphite black	10			
Matte black	11	10	5 Pronounced tarnish	910
Scaly black	12			

rosive nature of an oil, have correlated these thicknesses with "Indiana Copper Strip Numbers" based on Bolt's color series (4). A condensed version of this scale has been incorporated in ASTM Method D 130 – 50 T.[3]

Since the color series on which the scales are based is reported to be the result of interference phenomena, it is of interest to note the similarity between the series in Table I and that in Fig. 1. The latter is based on the progressive absorption of the indicated portions of the visible spectrum taken from W. R. Brode's treatise (3). While the physical results of exposing copper strips to corrosive media are well established, as yet much less is known about the chemical interactions which occur. However, it is not the purpose of this paper to consider the chemical aspect of the problem but rather to describe a method whereby more accurate data on corrosion can be obtained.

The mass of metal affected by moderately extensive corrosion of a test specimen is measured in micrograms. Consequently macrochemical techniques are not applicable to the appraisal of the extent to which the attack has progressed. Only microtechniques, such as the cathodic-reduction method of Matthews and Parsons (6), are useful. On the other hand, the film thicknesses equivalent to these quantities are in the optimum range for optical inspection.

A reasonably well-polished strip with most of the surface irregularities small in comparison to the wavelengths of visible light usually results from the application of the method in the 1950 issue of ASTM Standards on Petroleum Products and Lubricants[3] or in The Institute of Petroleum (London) Standards on Petroleum (7). However, a somewhat different situation prevails if Note 1 of the ASTM Method D 130 – 50[3] T is used alone as shown by the photomicrograph in Fig. 2. The irregularities in the surface of this strip are not small in comparison to the wavelengths of visible light. Furthermore, the heat and pressure associated with the grinding or polishing operations undoubtedly alter the refractive index of the copper surface by conversion of a crystalline to an amorphous surface (7).

Fig. 2.—Mechanically Polished Copper Strip (× 8.6).

An alternative surface preparation could be one that would be of a matte character, that is, one whose irregularities are uniform in size and randomly oriented. Optically, the difference in these two types of surface is tremendous. The smooth surface gives specular reflection and the matte surface diffuse reflection. The optics of these extremes are considered below in detail, including an illustration of the undesirability of intermediate surface types.

Optics of Films on Plane Surfaces

Given a surface which meets the planarity requirement, the reflection and refraction of light by a film of thickness t and refractive index n_2 upon this metal surface should be considered. It should be assumed also that the film is transparent in the range of interest. Figure 3 is a diagrammatic representation of this system.

Ray 1 indicates a beam of light striking the film at A. First the case in which this is monochromatic light should be considered and then, in order to delineate the range, the two wavelengths, λ, 4000 and 8000 Å which bracket the visible region of the spectrum. Rays 2, 3, and 4 are the direct-reflected, singly-internally-reflected, and double-internally-reflected rays. Rays 5 and 6 are representative of the portions of the electromagnetic energy which are lost by absorption.

It is of interest at this point to consider the maximum possible relative intensities which might be found in ray 2 if it were sufficiently large that rays 3 and 4 were not produced. Because of the difference in the electronic nature of dielectrics and metals, the relations expressing the relative intensities in the reflected light, given normal incidence, are different. For dielectrics the relation is

$$\frac{I}{I^0} = \frac{(n_2 - 1)^2}{(N_2 + 1)^2}$$

for metals it must be modified to

$$\frac{I}{I^0} = \frac{(n_2 - 1)^2 + n_2^2K^2}{(n_3 + 1)^2 + n_3K^2}$$

where K is the absorption or extinction coefficient of the metal, I and I^0 the intensities of reflected and incident light, and n_2 and n_3 are the refractive indices of film and metal.

For glass the relative intensity of the directly reflected beam is 0.04 or 4 per cent. For copper oxide or sulfide, the relative intensity for the refractive index given is about 22 per cent. For polished copper, it is also about 22 per cent up to a wavelength of about 6500 Å. Above this wavelength, the relative intensity rises to about 85 per cent. This accounts for the red color of copper.

Interestingly, if a transparent film with a greater refractive index than air is interposed between the incident light and the copper, the relative intensity of the beam reflected from point B is not 22 per cent but 51 per cent. Consequently, if the absorption by this film is small, the presence of the film results in an increase in the relative intensity of the reflected light.

Successive applications of the above intensity relations together with Lambert's law enable proof of this statement. If for the moment one ignores the contribution of ray 4 (as well as rays resulting from additional internal reflections), this procedure results in the equation given below for the system presented in Fig. 3:

$$I_\Sigma = I_2 + I_3$$

or

$$I_\Sigma = 0.224I^1[1 + 1.285e^{-8K_f(t)/\lambda}]$$

For very small values of t, $K_f = 0$, so that

$$I_\Sigma = 0.224I_1[1 + 1.285]$$

or

$$I_\Sigma = 0.512I$$

Furthermore, even for values of K_f of the order of 0.5, film thicknesses of 500 Å, and light of 5000 Å, values of $K_f(t)/\lambda$ of 0.05 will be obtained. The above relation, therefore, confirms the contention that, in the absence of interference phenomena, the relative intensity of light reflected from a film of greater refractive index than air is increased by the presence of the film. Ultimately the exponential term approaches the value characteristic of the specific material comprising the film.

The qualification with regard to interference phenomena should be noted. In

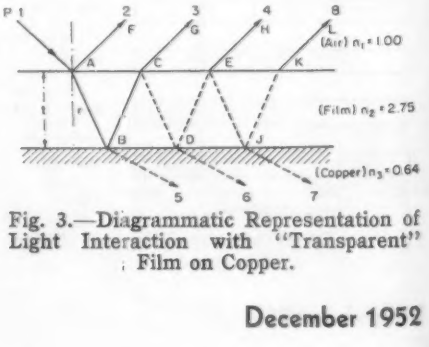


Fig. 3.—Diagrammatic Representation of Light Interaction with "Transparent" Film on Copper.

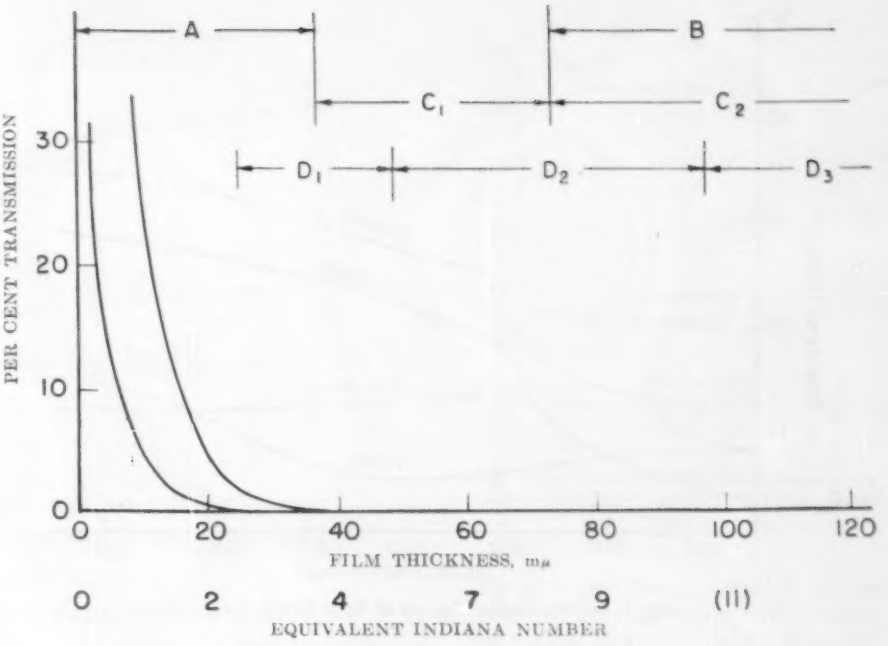
the case of smooth surfaces and monochromatic light, the operation of interference phenomena far outweighs absorption *per se*. Referring again to Fig. 3, one should consider the phase relations between rays 2 and 3 as a result of films of various *t*'s. First an infinitesimally thin film, one in which *t* is very small in comparison to the wavelength of the incident light should be considered. As long as this dimensional requirement is met, destructive interference results because of the 180-deg phase reversal which occurs at *A* but not at *B*. This phenomenon is commonly illustrated by calling attention to the black appearance of the top of the soap bubble just prior to its breaking. Obviously a 200 Å film with an internal path length of 400 Å for normally refracted light will cause less complete interference for the longer wavelengths of light than for the shorter. The result is greater reduction in the intensity of reflected short waves than in that for long waves. This is equivalent to greater absorption in the short wave end of the spectrum. Thus one "sees" light shorn of some violet light, that is, a yellow-orange color, see Fig. 1. This kind of interference is referred to in the texts as "thin-film interference."

As the film thickness *t* becomes larger, "thin-film interference" becomes less complete, but another kind of interference, so-called "thick-film interference," can arise. Its appearance conforms to the relation

$$2n_2 t \cos r = m\lambda \text{ (see Fig. 3)}$$

where:

n_2 = the refractive index of the film,
t = the thickness of the film,
r = the angle of refraction (assumed to be normal for illustration here),
λ = the wavelength, and
m = an integer, equivalent to the number of whole waves fitting the path from *A* to *B* to *C* (Fig. 3). [It will not be referred to as an "order" so that confusion will not arise in the comparison with the number of times this path is repeated within the film as a result of internal reflections, that is, comparing path lengths *ABC* and *ABCDE*.]



A — Thin Film Interference
B — Paths PAF + PRBG; $m = 1$; $\lambda = 4000$Å
C_1 — Paths PAF + PABCDEH; $m = 1$; $\mu = 4000$Å
C_2 — Paths as C_1 but $m = 1$; $\lambda = 8000$Å; or $m = 2$; $\lambda = 4000$Å
D_1 — Paths PAF = PABCDEJKL; $m = 1$; $\lambda = 4000$Å
D_2 — Paths as D_1 but $m = 1$; $\lambda = 8000$Å; or $m = 2$; $\lambda = 4000$Å
D_3 — Paths as D_1 and D_2 but $m = 2$; $\lambda = 8000$Å

Fig. 4.—Range of Film Thickness over Which Interference and Absorption Phenomena Operate.

To illustrate the range of film thicknesses necessary for thick film interference, sample calculations were made (Table II).

The film thickness may reach a value such that there is no secondary reflection from the underlying copper. At this point, the specific absorption characteristices of the film itself control the proportion of incident light which is reflected. Unfortunately no extinction coefficients for copper oxide or sulfide could be found, so that it was necessary to guess a representative value for this variable. On the indicated basis, a Lambert's law calculation was made which indicates that reflection from the underlying copper is eliminated because of absorption for film thicknesses above about 500 Å. Consequently colors resulting from light reflected from strips with Indiana numbers of about 6 and higher are the result of absorption, not interference, phenomena. All the above phenomena are summarized in Fig. 4, in which are indicated the ranges over which the various phenomena are operative.

TABLE II.—FILM THICKNESSES REQUIRED FOR DESTRUCTIVE INTERFERENCE.

	$m = 1$		$m = 2$	
	4000 Å	8000 Å	4000 Å	8000 Å
t, Å (Single passage through film)	727	1454	1454	2908
Equivalent Indiana Number	8	10	10	10
t, Å (Double passage through film)	364	727	727	1454
Equivalent Indiana Number	4	8	8	10
t, Å (Triple passage through film)	242	485	484	970
Equivalent Indiana Number	2-3	5	5	10

TABLE III.—COMPARISON OF INDIANA AND ASTM COPPER STRIP NUMBERS WITH REFLECTANCE MEASUREMENTS.

Crude Oil	Indiana Number	ASTM Number	Areas Under Reflectance Curves[a]	
			350 to 550 mμ	350 to 750 mμ
Velma	1	1	151	413
Schuler	2	1	102	335
Midway-Sunset	4	2	130	515
Oregon Basin	5	2	62	286
Wasson	6	2	118	364
Slaughter	6	2	62	260
Elk Basin	10	4	131	266
Yates	10	4	77	133
Goldsmith	10	4	47	99

[a] Area units are arbitrary. A setting was fixed on a planimeter and then used throughout the work.

The Effect of Films on the Color of Copper

There is considerable merit to the visual estimation of the color of a strip because the optical phenomena described above operate to eliminate the short wavelengths from the reflected light with the gradual shift of eliminated

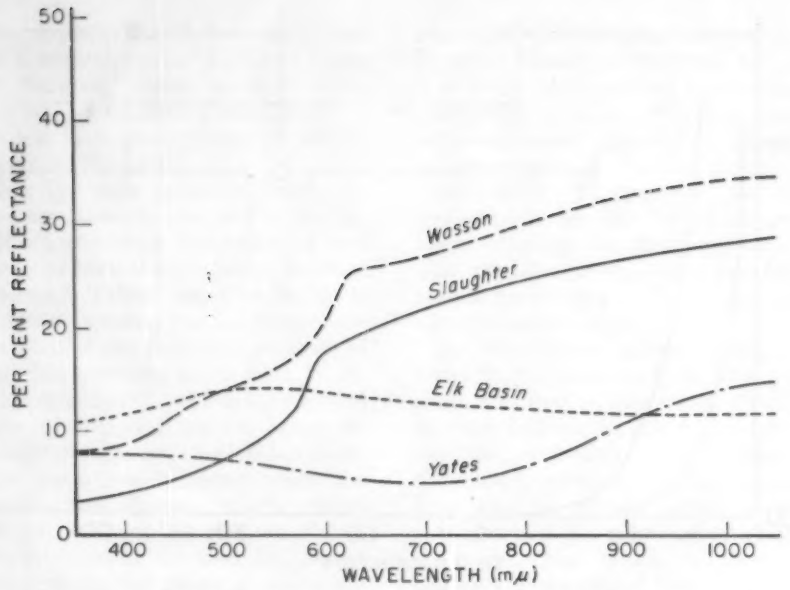


Fig. 5.—Reflectance Curves of Sour Crude Oils.

wavelengths toward the longer portion of the spectrum. This is apparent from Fig. 4, see also Fig. 1. Furthermore, the eye is an integrating instrument; that is, the area under the reflectance-wavelength curve is integrated to yield a resultant "color." It is just unfortunate that the sensitivity of the eye is extremely poor except between 425 and 575 mμ.

As a result, one would not expect a good correlation between Indiana numbers (which are, in effect, a rough estimation of film thickness) and the area under the reflectance curve. This has been found to be the case.

In Table III are presented the Indiana numbers assigned by an experienced estimator of the Gulf Research and Development Co. to mechanically "polished" strips after exposure according to ASTM requirements to rate corrosive oils. The ASTM numbers were assigned by a knowledge of relationship and the observed Indiana number. The strips after exposure and estimation were stored in helium until the reflectance curves shown in Figs. 5 and 6 could be obtained. The areas under these curves between 350 and 750 mμ are plotted against the Indiana number in Fig. 7.

Instrumental Observation of the Colors Arising from Films on Copper

The obviously poor definition of the degree of corrosion by visual means stimulated an attempt to apply instrumental color analysis. It was soon found that the instrument available, a Beckman ultraviolet spectrophotometer with reflectance attachment, possessed optical geometric characteristics that prevented reception of appreciable light if reflection was from a really plane surface. Light from this instrument strikes the specimen normally, and reflected light within the angle 35 to 55 deg is collected by a ring-shaped section of an ellipsoidal mirror and focused upon the photocell. Consequently variously prepared strips were tested to find a preparation that would give a maximum reflection. A mirror surface was prepared by polishing with rouge on a chamois-covered wheel. Mechanical polishing was done on other strips by Gulf Research and Development Co. Then sandblasting, anodic etching, and cathodic deposition were resorted to. The reflectance curves for these strips are shown in Fig. 8.

It is obvious that, as better and better matte surfaces were prepared, higher and higher reflectance was obtained. The probable results of using matte rather than smooth surfaces as corrosion test media were considered.

Initially the effect of films on the reflectance of matte copper surfaces was cause for surprise. As the film thickness increased, reflectance also increased. It was this apparent anomaly which stimulated the careful consideration of the optics involved. Ultimately it was realized that the random orientation of the microcrystal faces effectively eliminated interference phenomena by providing as many opportunities for constructive as for destructive interference. This is essentially the same reason that Fig. 2 is not an illustration of a "reflection grating." Elimination of interference phenomena places the entire dependence for color production on absorption; and, as has been shown above, this phenomenon operates to increase reflectance if the refractive index of the superposed film is greater than that of the air and of the base metal.

Matte-surfaced strips were exposed to samples of the same oils listed in Table III and reflectance curves obtained.

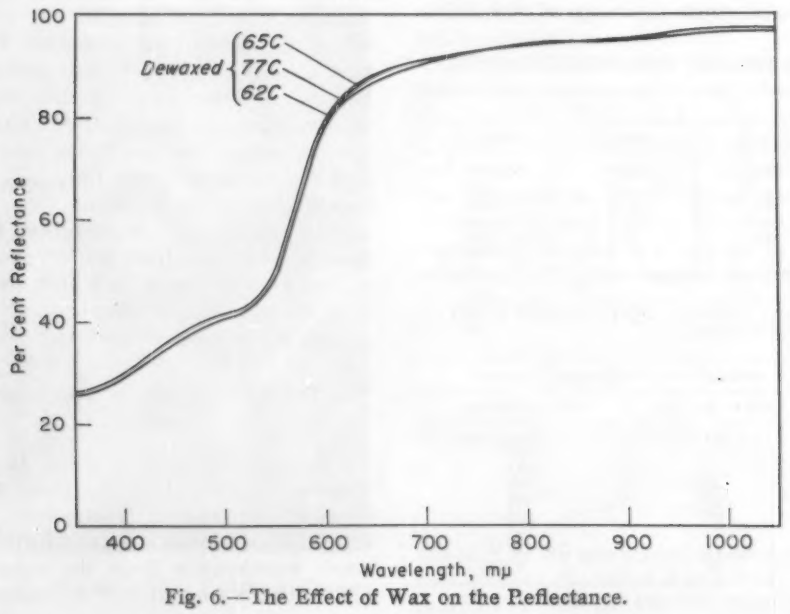


Fig. 6.—The Effect of Wax on the Reflectance.

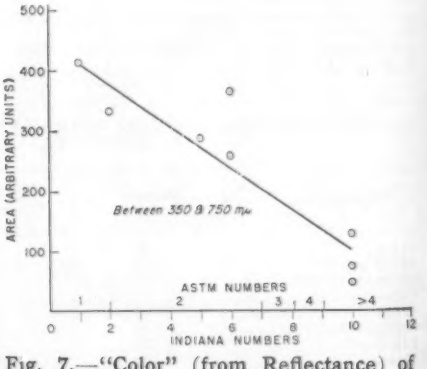


Fig. 7.—"Color" (from Reflectance) of Mechanically Polished Strips Against Indiana Numbers.

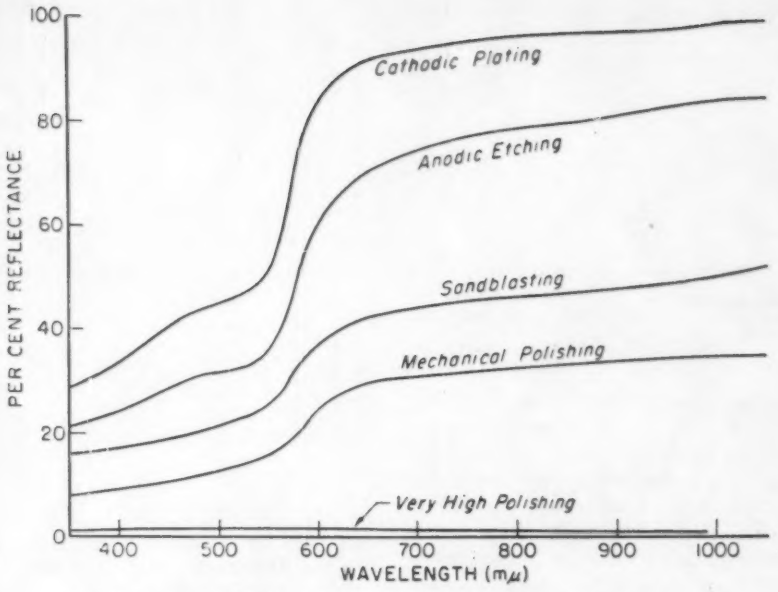


Fig. 8.—The Effect of Surface Irregularities on Reflectance.

The areas under these curves (between 350 and 750 mμ and between 350 and 550 mμ) were then plotted against the Indiana number of the film thickness produced by such exposure (Fig. 9).

Apparatus

Strips used in measuring corrosion were produced in a simple, multiple-strip plating cell. This device is illustrated in Fig. 10.

Copper strips 2 by $1\frac{1}{8}$ by $\frac{1}{16}$ in. were adopted so that a 1-in. circular area might be inspected. These strips were drilled and fastened to clips by means of brass machine screws. The clips were then attached to the copper tubing electrodes. The rigidity of the assembly was convenient because it could be quickly transferred from the alkaline cleaning electrolyte (for degreasing) to the acid dip (for removal of surface oxide), to the wash water, to the plating electrolyte, and then to the tap for final washing. The last washing operation should be carried out with the electrode rack inverted so that no oxide scale from the edge not immersed in treating solutions can be rinsed down to the active, plated surface.

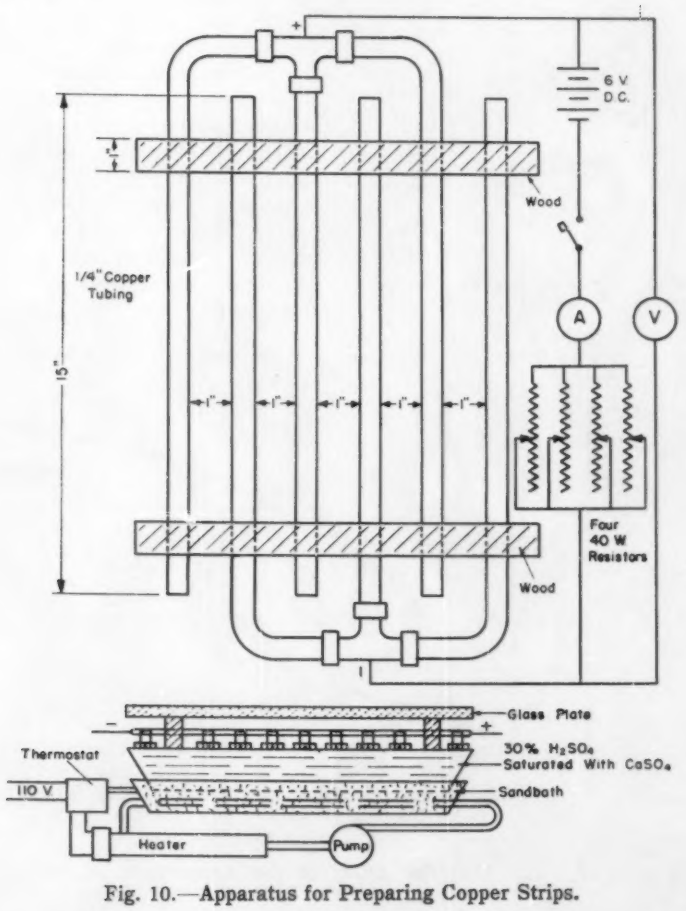


Fig. 10.—Apparatus for Preparing Copper Strips.

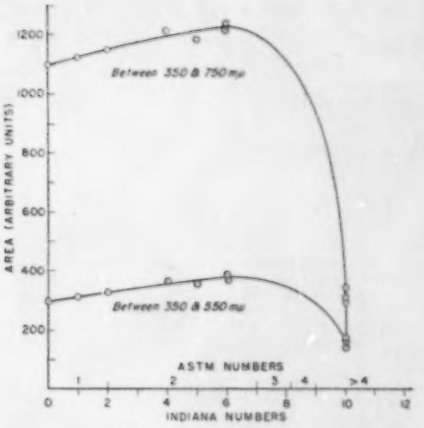


Fig. 9.—"Color" (from Reflectance) of Matte Surfaces Against Indiana Numbers.

Procedures

Preparation of Copper Strips:

The range of conditions found to be satisfactory for the plating of the strips is outlined in Table IV. In Fig. 11 are shown the effects of other variables.

The data illustrate the effect of temperature. It will be observed that at 50 C a much lower current density and longer time of operation were necessary to obtain results similar to those obtained with a higher current density at a higher temperature in a much shorter time. It is for this reason that a temperature of 60 C is preferred. At temperatures lower than about 45 C, gas and concentration polarization occur readily at a voltage of 0.3 to 0.4 v. Furthermore, at these lower temperatures current densities conveniently obtainable produce spongy deposits.

When the whole surface of the strip has been coated with microcrystals of copper—that is, when the thickness of the strip has been increased by $\frac{1}{32}$ to $\frac{1}{16}$ in.—the electrode assembly is removed from the bath, inverted, and washed with running tap water. The assembly of strips is then placed in distilled, preferably deaerated, water. If the strips are to be used immediately, they are transferred one at a time from the assembly to an acetone drying bath and then, after a short time has been allowed for the acetone to evaporate in air, to the oil to be tested. If the strips are to be stored until used, they may either be

TABLE IV.—MULTIPLE ELECTROLYTIC PREPARATION OF COPPER CORROSION STRIPS

Sample	Potential Drop, volts	Current, amp	Time, min	Temperature, deg Cent	Electrolyte[a]
Nos. 5043 to 5027.....	3.6	2.0	5	26.2	A
	none	none	0.25	26.2	B
	0.08	0.55	1020	50	C
Nos. 5043-28 to 5054..	4.5	3.0	5	25.8	A
	none	none	0.25	25.8	B
	0.21	2.0	180	60	C
Nos. 5043-55 to 5081..	4.0	3.0	5	26.7	A
	none	none	0.25	26.7	B
	0.21	2.0	180	60	C

[a] All electrodes were identical copper strips except during alkaline electrolysis when nine 2 by ¼-in. OD carbon anodes were used.
A—60 g per liter of sodium carbonate and 15 g per liter of sodium hydroxide.
B—Bright dip pickle composition was 435 ml of concentrated sulfuric acid, 72 ml of concentrated nitric acid, 2 ml of concentrated hydrochloric acid, and 491 ml of distilled water.
C—30 per cent sulfuric acid saturated with copper sulfate.

kept in an inert atmosphere or, after the evaporation of the acetone, be dipped in clean, molten paraffin.

Exposure of Copper Strips:

Crude oils, containing straight-run gasoline, were tested according to ASTM Method D 130 – 50 T,[3] whereas gas-oil solutions of pure compounds were tested according to ASTM Method D 484 – 40.[5]

The majority of the copper strips were dewaxed by immersion in hot toluene and then cold acetone just prior to testing the oil although some waxed test pieces were immersed in the oil under study in order to determine the effect of the wax. The variables of oil temperature and oil solvent power rendered the dewaxing process necessary. All strips, after exposure, were rinsed by dipping into hot toluene and then into cold, sulfur-free acetone.

Reflectance Measurements:

All measurements were made with the Beckman model DU spectrophotometer and its No. 2580 diffuse reflectance attachment. This instrument measures the relative reflectance between the copper strip and a magnesium carbonate standard surface. A selected monochromatic beam of light is directed by means of a reflection mirror onto the sample surface at an incident angle of 90 deg. All the rays reflected upward between 35 and 55 deg are focused by a ring-shaped section of an ellipsoidal mirror onto a phototube receiver.

Measurements on all copper strips were made between 350 and 1050 mμ. Between 350 and 650 readings were taken every 25 mμ and between 650 and 1050 they were taken every 50 mμ.

The reproducibility of the instrument readings is within ±0.2 reflectance units of the observed reflectance reading.

[5] Standard Specification for Stoddard Solvent (D 484 – 40) 1949 Book of ASTM Standards, Part 5, p. 923.

TABLE V. THE EFFECT OF WAXING PROCESS AND "AGING" ON REFLECTANCE.

	Area Under Reflectance Curves[a]	
	λ = 350 to 750 mμ	λ = 350 to 550 mμ
Waxed strip.....	973	238
Dewaxed strip.....	1265	389
Per cent reduction due to wax.....	5.69	38.8
Waxed strip 1st day..	835	198
Waxed strip 18 days later.....	823	184
Per cent change in 18 days	1.4	7.1

[a] Area units are arbitrary. A setting was fixed on a planimeter and then used throughout the work.

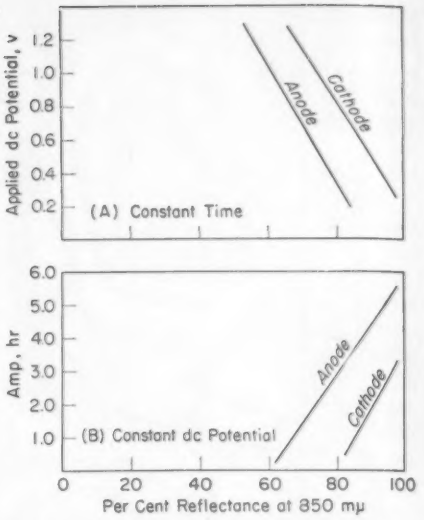


Fig. 11.—The Effect of Electrical Variables on the Reflectance of Etched and Plated Strips.

Other variables have increased this value to ±0.5 reflectance unit. The difference between these values is due mainly to orientation of the sample, discussed more fully later.

It occurs to the authors that the general utility of the method for field work would be greatly enhanced by the use of a filter-type spectrophotometer. The availability of many commercial models at moderate prices renders the adoption of an expensive, specially designed instrument unlikely. While there exists a real difference among the absolute reflectances of surfaces measured by different instruments, this could be surmounted by the adoption of a single instrument throughout industry. However, the empirical calibration of any instrument can be accomplished by anyone wishing to use this method.

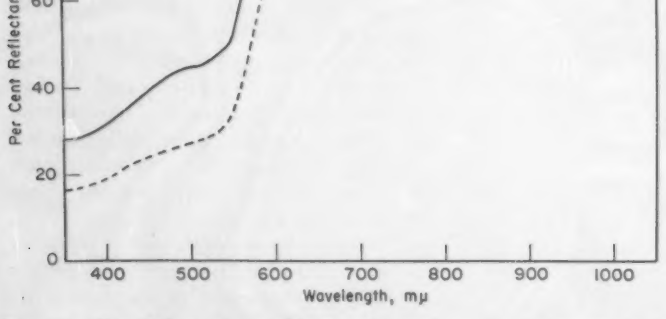


Fig. 12.—The Effect of the Waxing Process on the Reflectance of the Dewaxed Sample.

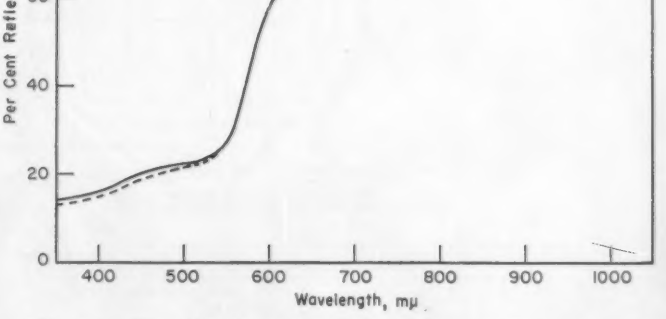


Fig. 13.—The Effect of the Atmosphere on Waxed Sample A-62-C.

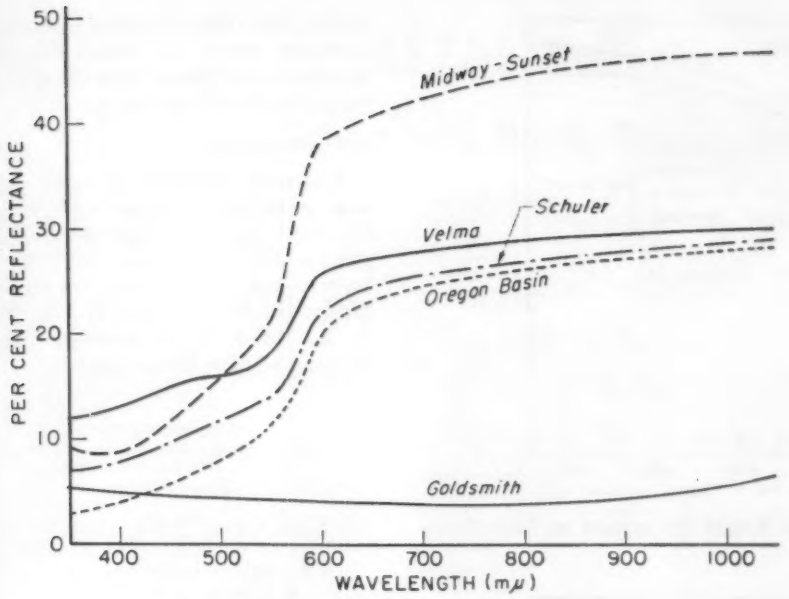


Fig. 14.—Reflectance Curves of Sour Crude Oils.

TABLE VI.—THE DEVIATIONS OF REFLECTANCES OF DEWAXED COPPER STRIPS.

	Areas Under Reflectance Curves	
	λ = 350 to 750 mμ	λ = 350 to 550 mμ
Dewaxed.....	1193	365
	1187	353
	1187	353
Average.....	1189	357
Average deviation.....	±3 (±0.25 per cent)	±4 (±1.1 per cent)

TABLE VII.—AREAS OF REFLECTANCE CURVES.

	Area	
	350 to 750 mμ	350 to 550 mμ
AREA *versus* CONCENTRATION OF C_4H_9SH		
Concentration		
0.....	932	238
1.0.....	875	250
2.0.....	811	208
3.0.....	780	189
AREA *versus* STRUCTURE		
0.....	932	238
n-propyl mercaptan.....	799	194
i-propyl mercaptan.....	795	173
n-butyl mercaptan.....	871	247
sec-butyl mercaptan.....	831	206
AREA *versus* CHAIN LENGTH		
0.....	932	238
n-propyl mercaptan.....	810	196
n-butyl mercaptan.....	873	246
n-decyl mercaptan.....	789	181

RESULTS

Figure 12 illustrates the fact that exposure of the strip to the waxing process (molten wax at 80 C) and then the dewaxing process (toluene at 110 C followed by acetone at room temperature) does not affect the reflectance of either the waxed or dewaxed strip. The waxing-dewaxing cycle was repeated four times with this strip. Figure 13 demonstrates the fact that eighteen days exposure of a waxed strip in a sulfurous laboratory atmosphere does not appreciably alter the reflectance of the dewaxed strip. It is instructive to consider the effects illustrated by these figures in terms of the areas beneath the curves. Table V shows that for each test there is a greater change in the short wavelength portion of the spectrum. The rather small change in the area under the "exposure" test curve could conceivably be a residual wax film. In any event, there were no immediately apparent objections to the use of paraffin wax as a removable protective coating.

An indication of the reproducibility with which strip preparation and definition (by reflectance measurement) may be carried out is given in Fig. 14 and Table VI. As a result of these good results, the general techniques of storing copper strips under a wax coating, which was removed before immersion in the oil, were adopted.

Possibly the most interesting results obtained were with sweet East Texas gas-oil solutions of pure sulfur compounds. The interesting aspect of these results is that not only could concentration differences be shown to affect corrosion, but structural factors were found to be equally measurable. In Table VII are presented the areas under the reflectance curves for copper strips exposed to the gas-oil solutions shown. The curves themselves are set forth in Figs. 15, 16, and 17.

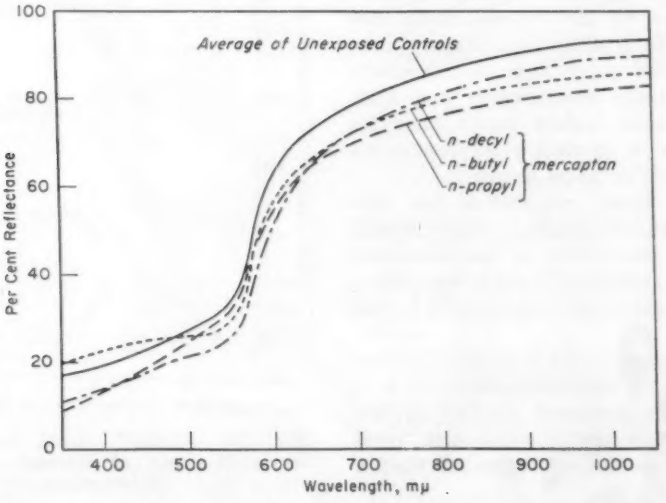


Fig. 15.—The Effect of Molecular Weight on the Corrosive Nature of Straight Chain Mercaptans.

CONCLUSIONS AND RECOMMENDATIONS

The correlations in Fig. 9 are much better than was anticipated. In confirmation of the picture previously given, they confirm the contention that at an Indiana Number of about 6 the specific absorption of the film material rapidly becomes the dominant phenomenon. One must also conclude that the achievement indicates that visual estimation of the color was a better and more reliable process than the preparation of the strips by mechanical polishing. This must be the explanation for the difference in the quality of the correlations in Figs. 7 and 9 although it may be partially the difference in the optics involved.

Figure 8 discloses that the area beneath the reflectance curve decreases steadily with increasing concentration beyond the maximum. There is just a suggestion that the corrosion rate is diminishing to a limit. More interesting possibly is the fact that the curve *B* for the range 350 to 550 mμ shows the initial increase in reflectance predicted and explained before. It will be noted that, if one assumes the data fit for the 350 to 750 mμ range (curve *A*...) as good as that in curve *B*, then a small maximum would appear.

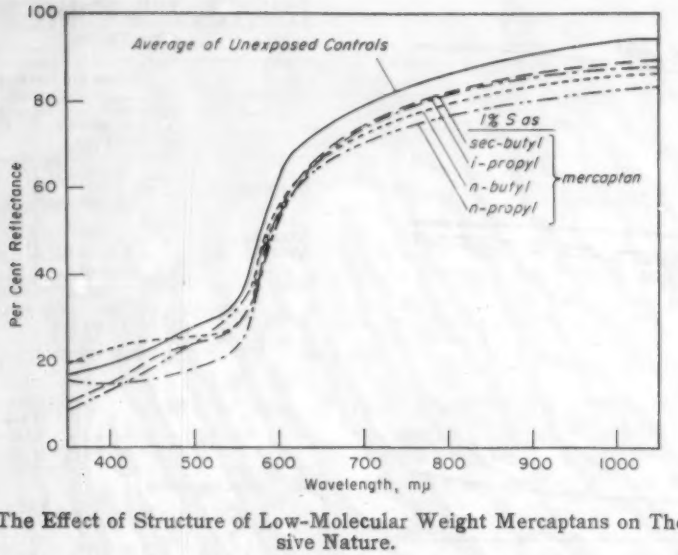


Fig. 16.—The Effect of Structure of Low-Molecular Weight Mercaptans on Their Corrosive Nature.

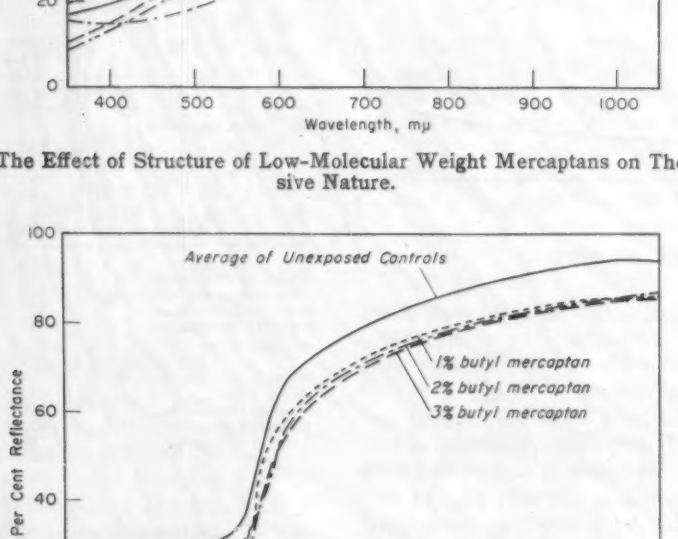


Fig. 17.—The Effect of Concentration on the Degree of Corrosion by Mercaptans.

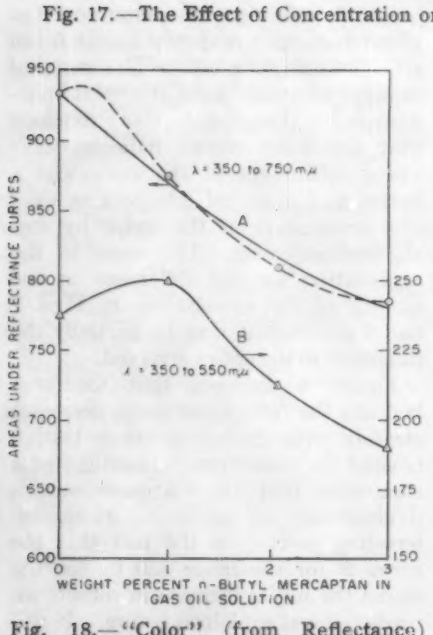


Fig. 18.—"Color" (from Reflectance) *versus* Concentration of Mercaptan.

Figure 19 reveals that the longer the chain length of a mercaptan the less corrosive it is and that secondary mercaptans are more corrosive than primary mercaptans. Extrapolation of the curves to the experimentally determined limit shows that primary mercaptans with six or more carbon atoms are essentially noncorrosive and that nine or more carbon atoms must be present in a secondary mercaptan to eliminate its corrosive nature.

While these conclusions are admittedly based on sketchy experimental data, the consistency of the latter and the corroboration of known reactivities tend to lend added significance to the results.

It is recommended that consideration be given to standardization upon a cathodically prepared microcrystalline matte surface for corrosion test specimens. It is further suggested that a simple, filter type of monochromatic reflectance meter be considered as a substitute for visual estimation of the color of such test specimens.

Acknowledgment:

The work described in these papers was carried out for Texas Gulf Sulphur Co., Inc. Its support and permission to publish this work are gratefully acknowledged. Thanks are also proffered for the helpful assistance of J. R. West, F. A. Miller, D. J. Anderson, W. J. Morar, and Miss Helen Golob.

References

(1) N. K. Adam, "The Physics and Chemistry of Surfaces," 3rd Edition, London, Oxford University Press, p. 170 *et seq.* (1941).

(2) J. A. Bolt, "Copper-strip Corrosion Tests," *Oil and Gas Journal*, Vol. 46, (14), p. 99 (1947).

(3) W. R. Brode, "Chemistry Spectroscopy," John Wiley and Sons, Inc., New York, N. Y., p. 231.

(4) G. Claxton and K. H. V. French, "The Corrosive Sulfur Test," *Journal*, Inst. Petroleum, Vol. 35, pp. 496–507 (1949).

(5) F. H. Constable, "Spectrophotometric Observations on the Growth of Oxide Films on Iron, Nickel, and Copper," *Proceedings*, Royal Soc. (London), Vol. A117, p. 376 (1928).

(6) F. W. H. Matthews and D. F. Parsons, "The Copper-strip Test—A Study of Current Methods of Interpretation and an Examination of Proposed New Procedures," *Proceedings*, Am. Petroleum Inst., Vol. III, 30M, p. 24 (1950).

(7) The Institute of Petroleum (London), Standard Methods for Testing Petroleum and Its Products, 10th Edition, London (1949).

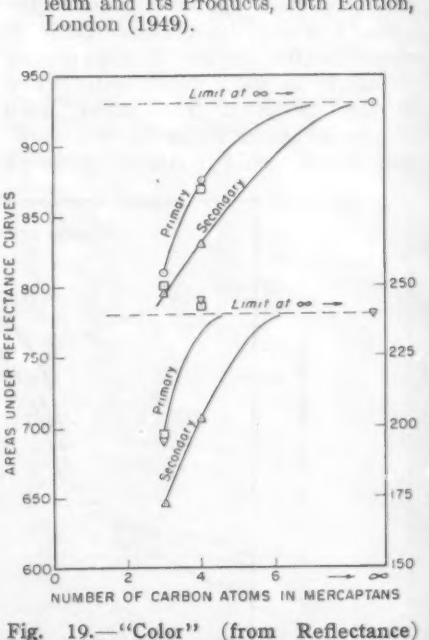


Fig. 19.—"Color" (from Reflectance) *versus* Number of Carbon Atoms in Mercaptans.

ASTM Bulletin—1952

Subject Index Papers, Reports, and Articles*

* Reprints of this Subject and Author Index are available to members on request.

Index to Authors of Technical Papers

PROFESSIONAL CARDS

Commercial Testing and Research:

- Chemical
- Metallurgical
- Physical
- Radiographic
- Spectrographic
- Sampling

COAL ANALYSIS PREPARATION

POWER PLANT ENGINEERING

COMMERCIAL TESTING & ENGINEERING CO.

228 N. La Salle St. Chicago 1, Illinois

Charleston, W. Va. Toledo, O. Cleveland, O
Terre Haute, Ind. Norfolk, Va.
Rochester, N. Y.

Member: American Council of Commercial Laboratories

SAM TOUR & CO., INC.

Mechanical, Chemical, Metallurgical Engineers — Consultants

Research & Development Laboratories

44 Trinity Place New York 6, N. Y.

The Haller Testing Laboratories, Inc.

801 Second Avenue, New York 17, N. Y.
Tel. MUrray Hill 4-5358

Testing and Inspection of Construction Materials

New York, N. Y. • Boston, Mass.
New Haven, Conn. • Plainfield, N. J.

THE JAMES H. HERRON COMPANY

Engineers, Chemists, Metallurgists

Consulting, Inspecting, Testing

Physical, Chemical, Metallographic & X-Ray Laboratories

1360–1364 West Third St., Cleveland, Ohio

PATZIG TESTING LABORATORIES

ENGINEERING INSPECTION
TESTS • ANALYSIS • RESEARCH
—OF—
EQUIPMENT • APPLIANCES
MATERIALS & PRODUCTS

Ingersoll Ave. & 23rd St. Des Moines, Iowa

Tests Performed Using

ROBINSON CUPOLA COMBUSTION CALCULATOR

Louis G. Robinson Laboratories
1108 Eastern Ave.
Cincinnati 1 Ohio

SMITH-EMERY COMPANY

Established 1910

Chemists — Engineers
Sampling, Analyzing, Assaying
Spectrography, Physical Testing

Member: American Council of Commercial Laboratories

920 Santee St. Los Angeles 15, Calif.

TEXTOR LABORATORIES, INC.

Analytical and Consulting Chemists
Referee Sampling and Analysis
Iron Ore and Coal Cargoes
Chemical Research and Development

Established 1895

1627 EAST 25th ST., CLEVELAND 14, OHIO

ST. JOHN X-RAY LABORATORY

Established 1925

CALIFON, NEW JERSEY

Phone: Califon 49

ELECTRICAL TESTING LABORATORIES, INC.

Electrical, Mechanical, Photometric, Radiometric, Chemical Laboratory and Associated Services

Certification, Inspections at Factories, and Field Investigations

2 East End Avenue *at* 79th St. New York 21, N. Y.

SOUTHERN LABORATORIES, INC.

Engineers — Chemists

Sub Soil Investigations
Physical, Chemical, and Soil Laboratories
Research & Inspection
Complete Model Shop

701 St. Michael St. Mobile, Alabama
907 Scanlan Bldg. Houston, Texas

LEDOUX & COMPANY, INC.

Chemists, Assayers, Engineers
Samplers and Weighers
Spectroscopists

359 ALFRED AVENUE
TEANECK, NEW JERSEY

CHARLES C. KAWIN COMPANY

METALLURGICAL CHEMISTS
FOUNDRY and METALLURGICAL ENGINEERS
METALLOGRAPHERS—SPECTROGRAPHERS
PHYSICAL TESTS

431 S. Dearborn St. Chicago 5, Ill.
P.O. Box 2035 Buffalo 5, N. Y.

SOUTHWESTERN LABORATORIES

Consulting, Analytical Chemists and Testing Engineers

Member A.C.C.L.

Inspections; Testing and Chemical Work

Fort Worth, Dallas, and Houston, Texas

A. W. WILLIAMS INSPECTION COMPANY

Timber and Timber Treatment Inspections
Also
Complete Chemical and Physical Testing Laboratories

EXECUTIVE OFFICE: Mobile, Alabama
BRANCH OFFICES: New York, N. Y., St. Louis, Mo.

ROBERT W. HUNT COMPANY ENGINEERS

Inspection, Tests, Consultation, Research

CHEMICAL, PHYSICAL, METALLURGICAL, CEMENT and CONCRETE LABORATORIES

175 W. Jackson Blvd., CHICAGO, *And All Large Cities*

LUCIUS PITKIN, INC.

ESTABLISHED 1885

Metallurgical Chemists & Consultants

Analysis—Sampling—Assaying
Spectrography—Metallography
Corrosion Studies—Research

PITKIN BLDG. 47 FULTON ST., N. Y. 38, N. Y.

Member: American Council of Commercial Laboratories

The Oldest Commercial Laboratory In America

BOOTH, GARRETT & BLAIR

Established 1836

Analytical and Consulting Chemists Samplers and Weighers

228 South Ninth Street Philadelphia 7, Pa.

PENNIMAN & BROWNE, INC.

Established 1896

CHEMISTS - ENGINEERS

Laboratory and Field Services
Inspection - Testing - Research

Member: American Council of Commercial Laboratories

341 ST. PAUL PLACE • BALTIMORE 2, MD.

STILLWELL & GLADDING, INC.

Inspection-Sampling-ANALYSIS of Chemicals, Drugs, Fats, Greases, Oils, Waxes, Fertilizers, Glycerine, DDT., B.H.C., Chlordane, etc., Pyrethrum, Rotenone Products, Soaps, Solvents, Tests, AOAC., ASTM., NF., USP., Tobacco. Est. 1868

130 Cedar Street, New York 6, N. Y.

Omaha Testing Laboratories

Chemists, Testing and Inspection Engineers

Testing, Inspection, Consultation, Design of all types of building and paving materials.

Investigation of Foundation Soils

511 South 20th St. Omaha 2, Nebraska

PROFESSIONAL CARDS

Below and on previous page are announcements by leading organizations and individuals of their services.

Testing • Inspection • Consulting
Product Development & Research
United States Testing Company, Inc.
Hoboken, N. J.
PHILADELPHIA • BOSTON • PROVIDENCE • MEMPHIS • DENVER
CHICAGO • NEW YORK • LOS ANGELES • DALLAS

BOWSER-MORNER TESTING LABORATORIES

Chemical—Metallurgical—Testing Engineers: Field and Laboratory Inspection and Tests—Chemical—Physical—Metallurgical—X-Ray—Diamond Coring—Environmental Testing

135-143 Bruen St. P.O. Box 51, Dayton 1, Ohio

W. B. COLEMAN & CO.

Metallurgists-Chemists-Engineers

Spectrographic Analysis
Chemical and Physical Testing
Metallurgical Investigations
Boiler Water Conditioning
Consultation Service

9th & Rising Sun Ave., Philadelphia 40, Pa.

INDUSTRIAL X-RAY
TESTING — ANALYTICAL
METALLURGICAL — CERAMIC
RESEARCH — LABORATORIES

Centrally located in New England

J. DIRATS & CO., INC.

Notre Dame Street
Phone 2260 Westfield, Mass.

OUTDOOR WEATHERING TESTS
in the sunniest, driest zone in the U.S.A. on Your products—under Your instructions.
PLASTICS • PAINTS • COLORS • FIBERS FABRICS • TUBES • PIPE • SHEETS

Accelerated ageing tests under intense solar radiation—about 200,000 langleys (1 gm. cal./sq. cm.) and 3,752 hours of brilliant sunshine yearly. No ice nor snow, no fog nor smog. 1100' elevation.

DESERT SUNSHINE EXPOSURE TESTS
7740 Ramona Road, Phoenix, Arizona

SHILSTONE TESTING LABORATORY

Chemists & Engineers

Spectrographic Analyses*

New Orleans, La. *Houston, Tex.

Inspection at all leading industrial centers

RESEARCH LABORATORIES
FOSTER D. SNELL INC.
29 WEST 15th ST. NEW YORK 11, N.Y. — WA 4-8800
CHEMISTS • ENGINEERS

RESEARCH
DEVELOPMENT
QUALITY CONTROL

DTL

554 BAGLEY
PHONE WO 1-6520
DETROIT 26, MICH.

THE DETROIT TESTING LABORATORY, INC.

South Florida Test Service

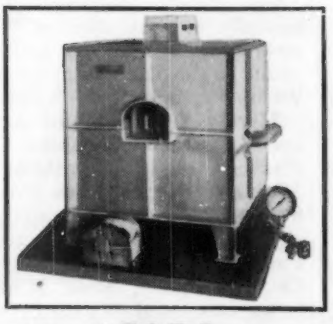
Testing • Research • Engineers

Consultants and specialists in corrosion, weathering and sunlight testing.

4201 N. W. 7th Street Established
Miami 34, Fla. 1931
Member: American Council of Commercial Laboratories

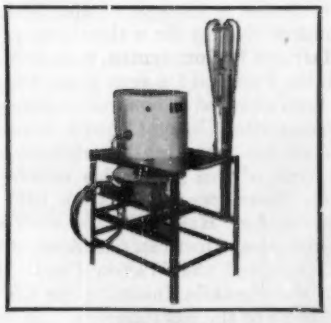
TEMPERATURES to 3100°F.-3500°F.
with REMMEY LAB KILNS

Kilns that feature close-control, wide temperature range and versatility. Extensively used in Quality Control—Research—Pilot Plant Firing—Ceramic Schools.



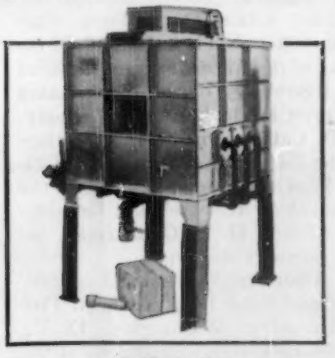
#2150

Setting Space—4½"x6½"x4". Temp. Range—1200°F. to 3100°F. Over-all Dimensions—Approx. 30"x30". Type—Gas-fired, semi-muffle; full muffle. Fuel—Propane, natural or city gas. Stack—none required.



#1800A

Setting Space—Cone plaque holds 22 cones. Temp. Range—Cone 40, as equipped. Over-all Dimensions—33"x53". Type—Revolving (2 RPM). Floscope controlled. Fuel—Oxygen and acetylene.



#2320

Setting Space—12"x18"x9". Temp. Range—1200° F. to 3200° F. Over-all Dimensions—Approx. 4'x4'. Type—Gas-fired, single valve control. Fuel—Propane, natural or city gas. Stack—not necessary but desirable.

#2350 (not shown)
Setting Space—24"x9"x7¼" high. Temperature Range to 3500°F.

REMMEY

Dependable Refractories

RICHARD C. REMMEY SON CO., PHILADELPHIA 37, PENNA.

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column.

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

At the recent annual meeting of the American Society for Metals the following men, all active in ASTM, were elected to office: **R. L. Wilson,** Chief Metallurgist, Steel and Tube Div., Timken Roller Bearing Co., Canton, Ohio, was named President; **J. B. Austin,** Director of Research, United States Steel Corp., Kearny, N. J., became Vice-President; **W. H. Eisenman,** National Secretary for the past 33 years, was re-elected; **H. B. Knowlton,** Chief Engineer, Materials Engineering, International Harvester Co., Chicago, and **A. O. Schaefer,** Vice-President in Charge of Engineering, Midvale Co., Philadelphia, were elected to the ASM Board of Trustees. Mr. Schaefer currently is serving a term on the ASTM Board of Directors.

Howard S. Avery, Research Metallurgist, American Brake Shoe Co., Mahwah, N. J., was winner of the 1952 Lincoln Gold Medal of the American Welding Society for his paper entitled "Hard Facing for Impact."

Edgar C. Bain, Vice-President in Charge of Research, United States Steel Co., Pittsburgh, Pa., was presented the Le Chatelier Medal, the Grand Medal of the French Society of Metallurgy, in Paris, in October during the Autumn Metallurgical Meeting, for his work and research in quenching of steels.

M. H. Bigelow, Technical Director, Plaskon Div., Libbey-Owens-Ford Glass Co., Toledo, Ohio, has been named Director-at-large of the Armed Forces Chemical Assn., and Secretary of the Great Lakes Section, Forest Products Research Society.

Miles D. Catton, Director of Development of the Portland Cement Assn., Chicago, has been appointed Assistant to the Vice-President for Research and Development, succeeding **H. F. Gonnerman,** retired after 30 years of service.

John A. Claussen, Chief, Pig Iron Section, Iron and Steel Div., National Production Authority, Washington, D. C., was one of several receiving awards at the 24th Annual Meeting of the Gray Iron Founders' Society, in recognition of outstanding contributions to the gray iron foundry industry. Mr. Claussen's citation read. . . "for his meritorious service with the War Production Board and with the National Production Authority, for his diligent and faithful devotion to the task of assuring the fair distribution of one of the Industry's vitally important raw materials during times of national emergency."

Lynn C. Davenport, until recently Superintendent, has been elected Vice-President in Charge of Operations, Mercer Tube and Manufacturing Co., Sharon, Pa.

J. H. Foote, President, Commonwealth Associates, Inc., Jackson, Mich., was awarded a certificate of service by the American Standards Assn., in recognition of his work in the development of American Standards. Presentation was made during a general session of the Third National Standardization Conference in Chicago in September, in conjunction with the Centennial of Engineering. Mr. Foote is one of the ASTM representatives on the ASA Standards Council. He is especially active in ASA affairs as a representative of the American Institute of Electrical Engineers on ASA Committee C7 on Bare Electrical Conductors. He also represents the Electric Light and Power Group on numerous ASA committees.

O. B. J. Fraser, Assistant Manager, Development and Research Div., International Nickel Co., Inc., New York City, has been given the Samuel Wylie Miller Memorial Medal by the American Welding Society for meritorious achievements in the art of welding.

Richard H. Frost was promoted to Chief Engineer, Stanley Aviation Corp., Buffalo, N. Y.

Ross L. Gilmore, President and General Manager, Superior Steel & Malleable Castings Co., Benton Harbor, Mich., has been elected a director of the Malleable Founders' Society for a three-year period.

Harrison F. Gonnerman, long associated with the Portland Cement Assn., Chicago, has been elevated to honorary membership by Committee C-1 on Cement, in recognition of his important contributions in the work of this group, his membership on the committee dating from 1927.

Edwin Loy Hall, Director of Testing Laboratories, American Gas Assn., Cleveland, received the Walton Clark Medal from the Franklin Institute, for his contributions to the gas industry.

Charles F. Hauck has been promoted to Assistant Sales Manager, Chemical Plants Div., Blaw-Knox Construction Co., Pittsburgh, Pa. In addition he will continue his duties as the division's manager of sales promotion. Prior to joining Chemical Plants Division a year ago, Mr. Hauck had 15 years' experience in chemical engineering and wet processing industries.

Richard C. Henshaw has been appointed Manager of Engineering for the Lord Manufacturing Co., Erie, Pa.

L. F. Hickernell, Chief Engineer, Anaconda Wire and Cable Co., Hastings-on-Hudson, N. Y., has been named Chairman of the recently formed Technical Operations Committee of the American Institute of Electrical Engineering.

Frank O. Hoagland, Master Mechanic, Pratt & Whitney Div., Niles-Bement-Pond Co., West Hartford, Conn., received the 1952 ASA Standards Medal "for leadership in the development and application of voluntary standards."

H. William Jewell, Chief, Research and Development, National Sewer Pipe Co., Ltd., Toronto, Canada, was elected President of the National Clay Pipe Research Assn., this organization consisting of clay pipe manufacturers in the United States and Canada.

William M. Lehmkuhl is now associated with the Lehon Co., Wilmington, Ill.

A. J. Liebman has been appointed an Assistant Director, Department of Research and Development, Dravo Corp., Pittsburgh, Pa.

Robert P. Liversidge was elected Vice-President in Charge of Electric Operations, Philadelphia Electric Co. He has been on the engineering staff of the company since 1932.

V. E. Mantz has been named Director of Government and Industrial Research, R. M. Hollingshead Corp., Camden, N. J.

H. S. Mattimore has joined the staff of Miller-Warden Associates, Consultants, Swarthmore, Pa. Formerly for many years Engineer of Materials, Pennsylvania Department of Highways, Mr. Mattimore is well known for his work in the road-building materials field. In recognition of distinguished service in many ASTM technical groups, he was awarded an ASTM Award of Merit at the Society's Fiftieth Anniversary Meeting in June.

Robert F. Mehl, Chairman of the Metallurgical Advisory Board of the National Academy of Sciences, National Research Council, and Head of the Department of Metallurgy at Carnegie Institute of Technology, received the 1952 ASM Gold Medal Award, this award being made annually in recognition of "outstanding metallurgical knowledge and exceptional ability in the diagnosis and solution of diversified metallurgical problems."

Murray Olyphant, Jr., formerly Research Assistant, Princeton University, Plastics Labs., is now with the Minnesota Mining & Mfg. Co., New Products Div., St. Paul.

John Romann has been named Vice-President and General Manager, Prescott Co., Menominee, Mich. Until recently he was associated with the U. S. Engineering and Manufacturing Co., Chicago.

Jason Saunderson is now Director of Engineering, Baird Associates, Inc., Cambridge, Mass.

Sherwood B. Seeley was promoted to Technical Director of Joseph Dixon Crucible Co., Jersey City, N. J.

Richard P. Seelig, formerly with the American Electro Metal Corp., Yonkers, N. Y., is now Executive Vice-President, Chromalloy Corp., New York City.

Arthur L. Smith, until recently Manager, Research & Development, Continental

(*Continued on page 74*)

(*Continued from page 72*)

Can Co., Inc., Cambridge, Ohio, is now with Rohm & Haas Co., Research Dept., Bristol, Pa.

Cyril S. Smith, Director, Institute for the Study of Metals, University of Chicago, was awarded the Francis J. Clamer Medal of the Franklin Institute (Philadelphia) for "his work leading to knowledge of the basic factors of the metallurgical behavior of elemental plutonium essential to the development of nuclear energy." Dr. Smith was associate division leader in charge of metallurgy at Los Alamos from 1943 to 1946.

Robert B. Sosman, Department of Ceramics, Rutgers University, New Brunswick, N. J., has been made an Honorary Member of the American Ceramic Society, in recognition of his outstanding achievements in the ceramic field and his many contributions to the Ceramic Society. A past-president of the Society and member since 1914, Dr. Sosman also is active in numerous other technical and scientific organizations. He has headed ASTM's Committee C-8 on Refractories since 1948.

Sidney J. Stein, until recently Assistant Research Director of International Resistance Co., Philadelphia, has been promoted to Director of Research for the company, and also has been appointed to the company's operating committee.

William H. Stephenson, formerly with the Columbia Gas System Service Co., Columbus, Ohio, has accepted an appointment as Industrial Engineer with the Ohio Fuel Gas Co., Toledo.

Arthur U. Theuer has returned from French Morocco, Africa, where he was associated for some time with Porter & Urquhart. He is now with Fay, Spofford & Thorndike, Beckley, W. Va.

James S. Vanick, Research Metallurgist, The International Nickel Co., Inc., New York City, and Chairman of ASTM Committee A-3 on Cast Iron, was honored at the recent annual meeting of the Gray Iron Founders' Society when he received an award for "outstanding contributions to metallurgical knowledge, improved production, and wider use of gray iron products, for his unstinting aid to foundrymen everywhere in the solution of industry problems, and for his valuable services in guiding the activities of the Society's Handbook and Technical Committees."

T. H. Wickenden, Vice-President in Charge of Development and Research, International Nickel Co., Inc., New York City, has been elected a member of the Welding Research Council of the Engineering Foundation for a three-year term.

Edward W. Wiederhold has accepted a position as Assistant Chemical Engineer, Mound Laboratory, Miamisburg, Ohio.

John W. Whittemore, Professor of Ceramic Engineering, Virginia Polytechnic Institute, has been appointed Dean of Engineering at VPI.

William P. Yant, Director of Research and Development, Mine Safety Appliances Co., Pittsburgh, Pa., has been elected Vice-President for Industry of the National Safety Council, and Chairman of that organization's Industrial Conference.

NEW MEMBERS···

The following 59 members were elected from September 26, to November 12, 1952, making the total membership 7354... Welcome to ASTM

Note—Names are arranged alphabetically—company members first then individuals.

Chicago District

DITTMORE, RAY H., Partner, Dittmore & Freimuth Co., 2517 E. Norwich St., Cudahy, Wis.

DUFFY, H. J., Plant Industrial Engineer, Line Material Co., South Milwaukee, Wis.

LARSON, M. ROBERT, Metallurgical Engineer, Holcroft & Co., Detroit, Mich. For mail: 6545 Epworth Blvd., Detroit 10, Mich.

Cleveland District

MIELZINER, WILLARD S., President, The Impact-O-Graph Corp., 1900 Euclid Bldg., Cleveland 15, Ohio.

RIPLING, EDWARD J., Senior Research Associate, Case Institute of Technology, University Circle, Cleveland, Ohio.

RUTZLER, JOHN E., JR., Assistant Professor Physical Chemistry, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio.

Detroit District

SMALL, LOUIS, President, Service Diamond Tool Co., 2505 Burdette, Ferndale, Mich.

New England District

DANIELS, RUTHVEN H., Assistant Chief of Test and Development, The Kaman Aircraft Corp., Windsor Locks, Conn.

LORD-WOOD, E. H., Director of Public Works, City of Norwich, 23 Union St., Norwich, Conn.

New York District

ANACONDA ALUMINUM CO., F. O. Case, President, 25 Broadway, New York 4, N. Y.

HOGGSON AND PETTIS MFG. CO., THE, Carl A. Stephan, Secretary-Treasurer, Box 1650, New Haven 7, Conn.

BUNKER, CARLETON H. President, Diamond Expansion Bolt Co., Inc., Garwood, N. J.

HUGHES, W. GERARD, Consulting Engineer, 16 Derbyshire Pl., Utica 3, N. Y.

KALIFON, SAM, Chief Inspector, Hatfield Wire and Cable, Hillside, N. J.

PAVLO. E. LIONEL, Consulting Engineer, 7 E. Forty-seventh St., New York 17, N. Y.

Northern California District

BASALT ROCK CO., INC., A. G. Streblow, President, Eighth and River Sts., Napa, Calif.

BAXTER AND CO., J. H., R. K. McCulloch, 200 Bush St., San Francisco 4, Calif.

Ohio Valley District

GROVER, HORACE J., Research Supervisor, Battelle Memorial Institute, 505 King Ave., Columbus, Ohio.

REYNOLDS, NOBLE N., Foreman, Purchased Material Inspection, Radio Corp. of America, RCA Victor Division, Indianapolis, Ind. For mail: 4823 English Ave., Indianapolis 1, Ind.

VIANEY, LUCIEN R., Research Engineer, Gunnison Homes, Inc., New Albany, Ind.

Philadelphia District

BISHOP AND CO., J., Platinum Works, Thomas S. Smith, Electrical Engineer, Malvern, Pa.

BACHNER, MARTIN, Manager, Velon Plastics Labs., Firestone Plastics Co., Pottstown, Pa.

MACE, ALBERT E., District Representative, Emil Greiner Co., 20–26 N. Moore St., New York 13, N. Y. For mail: Box 106, Paoli, Pa.

Pittsburgh District

SYNTRON CO., Edward J. Missien, Assistant to President in charge of Engineering, Homer City, Pa.

WALSH, DONALD E., Consolidated Feldspar Co., Trenton, N. J. For mail: 2507 St. Clair Ave., East Liverpool, Ohio.

YEAGER, H. K., Assistant Metallurgical Engineer, Alloy, United States Steel Co., 525 William Penn Pl., Pittsburgh, Pa.

St. Louis District

HASHBARGER, H. A., Development Dept., Monsanto Chemical Co., 800 N. Twelfth Blvd., St. Louis 1, Mo.

WILSON, RICHARD W., Chief Metallurgist, American Hoist and Derrick Co., 63 S. Robert St., St. Paul, Minn.

Southern California District

REINFORCED PLASTIC CONSULTANTS AND ENGINEERS, Robert W. Matlock, Administrator, 1603 W. 135th St., Gardena, Calif.

CHRISTIANSEN, GERALD G., California Portland Cement Co., Box 111, Colton, Calif.

COLLIER, ROBERT T., President, R. T. Collier Corp., 714 W. Olympic Blvd., Los Angeles 15, Calif.

DOCKENDORF, DONALD O., Director of Quality Control, Rosin Industries, Inc., Oliver and Gutierreg Sts., Santa Barbara, Calif. For mail: Box 1589, Santa Barbara, Calif.

MOCERINO, NICHOLAS J., Design Engineer, Reinforced Plastic Consultants and Engineers, 1603 W. 135th St., Gardena, Calif. For mail: 1863 Pandora Ave., West Los Angeles 25, Calif. [J]*

MYERS, NORBERT C. Reinforced Plastic Consultants and Engineers, 1603 W. 135th St., Gardena, Calif. [J]

OLEESKY, SAMUEL S., Chief Electronics Scientist, Reinforced Plastic Consultants and Engineers, 1603 W. 135th St., Gardena, Calif. For mail: 1627 S. Sherbourne Dr., Los Angeles, 35, Calif.

Washington (D. C.) District

ABRAHAMS, FRANK, Assistant Construction Supervisor, Welsh Construction Co., 11 E. Fayette St., Baltimore, Md. For mail: 7022 Park Heights Ave., Baltimore 15, Md. [J]

ACHHAMMER, BERNARD G., Assistant Chief, Organic Plastics Section, National Bureau of Standards, Washington 25, D. C.

BENNETT, JOHN A., Chief Mechanical Metallurgy, National Bureau of Standards, Connecticut and Van Ness Sts., Washington 8, D. C.

HYDE, GLENN F., Supervising Engineer, Koppers Co., Inc., Metal Products Div., Bush and Hamburgh Sts., Baltimore 30, Md.

POLETIKA, NICHOLAS V., Assistant Director of Research, Timber Engineering Co., 1319 Eighteenth St., N. W., Washington, D. C. For mail: 4812 Minnesota Ave., N. E., Washington 19, D. C.

PORTER, ROBERT F., Vice-President in Charge of Sales, Harry T. Campbell Sons' Corp., Towson 4, Md.

SHREVE, E. C., Chief Engineer, Western Maryland Railway Co., Hillen Station, Baltimore 2, Md.

SKAGERBERG, RUTCHER, Director, Operations Engineering, Public Housing Administration, Longfellow Bldg., Washington 25, D. C. For mail: 420 Tyler Pl., Alexandria, Va.

Western N. Y.-Ontario District

ANCHOR CONCRETE PRODUCTS, INC., Fred W. Reinhold, President, Wabash at 2450 William St., Buffalo 6, N. Y.

WOODBURN, JAMES, Assistant Technical Director, Electrode Division, Great Lakes Carbon Corp., Box 637, Niagara Falls, N. Y.

U. S. and Possessions

TUFTED TEXTILES MANUFACTURERS ASSO-

(*Continued on page 76*)

(*Continued from page 74*)

CIATION, Henry C. Ball, Executive Vice-President, Box 256, Dalton, Ga.

BENZ, GEORGE R., Manager, Engineering Dept., Phillips Petroleum Co., Adams Bldg., Bartlesville, Okla.

BERG, W. H. C., Chief Engineer, Powers Manufacturing Co., Box 2428, Longview, Tex.

BURNETT, G. E., Engineer, Bureau of Reclamation, Denver Federal Center, Denver, Colo.

CRANDALL, CHARLES B. Statistician, Cotton Merchandising Research, Box 1645, University of Texas, Austin, Tex.

RANSEY, IRA A., Architect, 115 Kingston St., Lenoir City, Tenn.

TENNESSEE AGRICULTURAL AND INDUSTRIAL STATE UNIVERSITY, LIBRARY, Benson L. Dutton, Chairman, School of Engineering, Nashville 9, Tenn.

WASHINGTON STATE INSTITUTE OF TECHNOLOGY, DIVISION OF INDUSTRIAL RESEARCH, R. L. Albrook, Director, Pullman, Wash.

Other than U. S. Possessions

BASTIEN, PAUL GASTON, Director of Research, Professor of Metals Physic, Société des Forges and Ateliers du Creusot, 15, Rue Pasquier, Paris 8°, France.

BOND, G. W., Chief Chemist, Electricity Supply Commission, Box 1091, Johannesburgh, South Africa.

FRAIKIN, LEON A., Professor of Applied Soil Mechanics, École Polytechnique, University of Montreal, Rue St. Denis, Montreal, P. Q., Canada. For mail: 376 Grenfell Ave., Mount Royal, P. Q., Canada.

LEJA, ERNEST ALBERT, Managing Director, North Star Cement, Ltd., and Atlantic Gypsum, Ltd., Corner Brook, Newfoundland, Canada. For mail: 66 Reid St., Box 436, Corner Brook, Newfoundland, Canada.

SITTENFELD R. MAX, Assistant Professor, Testing Materials, Box 1034, San José, Costa Rica. [J]

THORSSEN, LEROY ALLAN, Consulting Engineer, Materials Testing Laboratories, Ltd., Box 116, Edmonton, Alberta, Canada.

* [J] denotes Junior Members.

Research Firm Expands Foreign Service

ARTHUR D. LITTLE, INC., a leading industrial consulting research firm of Cambridge, Mass., and long-time ASTM member, has announced the establishment of an International Division to meet the increasing demand for its services in international areas.

The new Division, headed by A. G. Haldane, who was previously with the U. S. Department of Commerce, offers Arthur D. Little Inc.'s clients outside the United States the services of the company's staff of scientists, engineers, and technical economists as consultants for their particular industrial development, engineering, and economic problems.

In announcing the new International Division, E. P. Stevenson, President, said that interest in taking advantage of technical development has increased throughout the world in recent years. The establishment of this new division, he added, represents a reorganization of the administration of the firm's extensive work outside the United States. The division will coordinate assignments so that clients abroad can draw upon the services of the company's entire staff of over 550, including industrial specialists, engineers, chemists, physicists, biologists, market analysts, and patent specialists.

NECROLOGY...

The death of the following members has been reported

GEORGE E. BEAN, Managing Director, Eastern Malleable Iron Co., Wilmington, Del. (October 6, 1952). Representative of company membership since 1944; also representative of his company on Committee A-7 on Malleable-Iron Castings, serving on the advisory group and several subcommittees. He had been Chairman of Subcommittee V on Malleable Iron Flanges, Pipe Fittings and Valve Parts for the past two years.

THORWALD A. CARLSON, Principal Engineer, U. S. Forest Products Laboratory, Madison, Wis. (October 24, 1952). Affiliated with ASTM since 1937, Mr. Carlson had rendered valued service in Committees D-6 on Paper and Paper Products, and D-10 on Shipping Containers, serving as chairman of the latter group for the past six years. He also was chairman of the Joint TAPPI-ASTM Committee on Shipping Containers. A research engineer at Forest Products Laboratory for 31 years, Mr. Carlson had specialized in packaging, and was nationally known as a packaging expert. He had directed far-flung packaging operations of the military forces during World War II as chief of packaging research at Forest Products Laboratory, organizing and guiding a staff of experts that numbered, at the peak of the war activities, more than 150 men and women. Besides doing packaging research for the various Government agencies, his staff visited manufacturing and shipping centers throughout the United States and abroad for special packaging consultation work. He headed a packaging mission to England in 1943. By means of extensive tests, and reports of his findings in technical and trade journals he succeeded in bringing many kinds of wood into use, despite strong prejudice on the part of container manufacturers and users, thus helping to broaden the base of container wood supplies when demand became heavy during wartime.

Mr. Carlson was a native of East Helena, Mont., where he was born July 21, 1893. A graduate (1917) of the University of Wisconsin, in his earlier years he held research positions with the Anaconda Copper Co. and the American Smelter and Refining Co., also served during World War I as Army chemist at American University in Washington, D. C.

He was held in high esteem by all his ASTM associates, not only because of his technical knowledge and abilities, but also for his fairmindedness and his pleasing personality.

FRED S. CARVER, Engineer and Manufacturer of Hydraulic Machinery, Summit, N. J. (August 15, 1952). Member since 1929.

GUSTAVUS J. ESSELEN, Vice-President, United States Testing Co., Boston, Mass.; and President, American Council of Commercial Laboratories (October 22, 1952). A graduate of Harvard University, and a leader in the field of industrial research, Dr. Esselen in his earlier years had served as Research Chemist for General Electric Co., and as Research Director for Skinner, Sherman, and Esselen. In 1930 he established his own laboratory. In 1950 the Esselen Research Corp. merged with the U. S. Testing Co., becoming known as the Esselen Research Division. A member and director of numerous technical groups and organizations, Dr. Esselen was affiliated with ASTM for many years, and had served on a number of ASTM technical committees.

ROBERT S. JOHNSTON, Yardley, Pa.; formerly Director of Research, John A. Roebling's Sons Co., Trenton, N. J. (September 26, 1952). Member since 1919, and for many years member of the following technical committees: A-1 on Steel, B-3 on Corrosion of Non-ferrous Metals and Alloys, former D-14 on Screen Wire Cloth, and E-2 on Spectrographic Analysis.

THOMAS G. JOHNSTON, Metallurgical Engineer, Pig Iron and Coal Chemicals Div., Republic Steel Corp., Cleveland, Ohio (October 10, 1952). Representative of his company since 1944 on Committee A-3 on Cast Iron, serving on Subcommittee I on Pig Iron.

OTTO K. KASPEREIT, Frankford Arsenal, Philadelphia, Pa. (September 18, 1952). Representative of U. S. Department of the Army, Ordnance Department, since 1937 on Committee C-14 on Glass and Glass Products.

E. C. PAGE, Owner, Page Testing Laboratory, Ventura, Calif. (August 16, 1952). Member since 1946.

HENRY W. PLEISTER, President, Diamond Expansion Bolt Co., Garwood, N. J. (April 17, 1951). Member of Society and of Committee A-5 on Corrosion of Iron and Steel since 1926.

B. J. SCHMID, Department of Engineering, Pacific Gas and Electric Co., San Francisco, Calif. Representative of his company on Committee A-1 on Steel since 1950.

F. M. WARING, formerly Engineer of Tests, Pennsylvania Railroad Co., Altoona, Pa. (October 11, 1952). Many ASTM members, particularly those active in the Steel Committee and other groups working with materials of concern to the railroads, will learn with regret of the death of F. M. Waring, associated with the Society since 1913. Although for many years his most intensive activities were concentrated in Committee A-1 on Steel, where for a long time he was Chairman and Secretary, and had been elevated to honorary membership of the committee, he also had served for long periods on Committees A-2 on Wrought Iron, C-1 on Cement, D-11 on Rubber (Secretary, 1914–1918), and E-1 on Methods of Testing. He served on the Board of Directors for a term (1936–1937). On his retirement from the Pennsylvania Railroad some years ago he came to Philadelphia, and made his home at the Engineers' Club.

NEWS NOTES ON

Laboratory Supplies and Testing Equipment

Instrument Notes

Torsion Machine for Oil Well Drill Pipe—A new torsion machine with unusual design features has been built by Baldwin-Lima-Hamilton Corp., for the testing of tool joints on oil well drill pipe. The machine measures torque in either direction of twist and has two open chucks which permit running any length and size of drill pipe through the machine. These openings are 10¼ in. in diameter. The machine is to be used solely for screwing up and unscrewing tool joints as is done on rotary drilling rigs when hoisting the drill stem and returning it into the well. Capacity of the machine is 600,000 inch-pounds in either direction with 500 inch-pound graduations on the indicator dial. A lower range of 120,000 inch-pounds is indicated by 100 inch-pound graduations. Torque is applied in two speed ranges: from 1 to 6 rpm for screw-up approach and from 0 to 1 rpm for "bucking up" the tool joint. A slipping clutch is provided because of the rapid load rise when shoulders of the joint meet. Distance between chucks may be set anywhere between 4 in. and 100 in. by moving the control and indicator cabinet on its track.

Baldwin-Lima-Hamilton Corp., Paschall Station P. O., Philadelphia 42, Pa.

Precision Metering Pumps—A new metering pump is said to offer utmost accuracy and dependability in the metering of small volumes of liquid. The new line of "Maisch Metering Pumps" embraces capacities ranging from zero to 3.6 gallons per min. The design is said to permit metering with accurate control volume ranging from 0 ml per sec to maximum capacity. It is recommended for the dispensing of hot or cold viscous or non-viscous liquids such as soaps, oils, perfume, liquid fats, grease, wax, glue, and numerous chemicals and compounds.

Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.

Miniature Pressure Transducer—Pressure measurements ranging from theoretical investigations of aircraft turbulence-distribution patterns to practical surveys of hydraulic-system and pipeline pulsations are said to be simplified by a minature pressure transducer announced by Consolidated Engineering Corp. One of the smallest instruments of its type ever designed for quantity production, the new Type 4-310 "Star" Pickup measures only ½ in. in diameter and less than ¾ in. in length. Its flush diaphragm is designed for insertion directly into a process vessel or stream of either liquid or gas for test and monitoring purposes. In missile testing and wind-tunnel model applications, its small size and light weight—only 20 oz—are said to make possible direct instrumentation to a degree not heretofore possible. The unit may be used with recorders for permanent test records or with visual indicators and meters for on-the-spot measurements.

Bulletin CEC 1534, Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

All Purpose Ultra Violet Unit—An all purpose ultraviolet laboratory unit built into a storage and carrying case, has been announced. It is called the "Cooper Hewitt Researcher." Ultraviolet energy is furnished by a 400 watt high pressure quartz mercury arc lamp with an envelope of clear fused quartz. A mounting assembly allows adjustment of the lamp housing to any position in the vertical or horizontal plane. A double tiered filter holder is supplied with each unit to accommodate selective filters for fluorescence investigation or other special requirements. When not in use, mounting assembly lamps and filters are stored in the carrying case thereby eliminating possibility of damage and facilitating storage. The unit is supplied for 110 volt, 60 cycle. Other voltages and frequencies can be supplied upon request.

Cooper Hewitt Electric Co., 720–732 Grand St., Hoboken, N. J.

Electro-Analyzer—A copper assay in eight minutes is claimed for the new "Eberbach Ultra-Speed Electro-Analyzer." This single position unit has a production rate said to be substantially equal to four positions on conventional apparatus. For example, in a copper assay, an analytically complete deposition of a one gram copper sample is accomplished in eight minutes or less. Improved cell design, in combination with an electromagnetic field claimed to be unique, and greater current flow produce the increased speed.

Bulletin 390, Eberbach Corp., Ann Arbor, Mich.

New Semi-Micro Centrifuge—Like the other Fisher "Safety" centrifuges (the Clinical and the Micro), a new Fisher "Semi-Micro" has an aluminum head dynamically balanced at the centrifuge's 1725 rpm. Result of this in-motion testing is said to be a noiseless, vibrationless operation. Company engineers report that the unit will coast for three minutes from full speed, not disturbing even the lighter, fluffier precipitates. Stability is said to result from the unit's heavy-casting base and low (5½ in.), wide (11 in.) design. The centrifuge's brushless, sparkless motors are designed to eliminate fire hazards, while danger from broken glass is said to be eliminated by the concealment of the tubes within the aluminum head. In the unit, the centrifuge tubes are held at a fixed angle of 55 deg. from the axis of rotation.

Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Pocket Hardness Tester—Now available is a new low cost portable pocket hardness tester for determining the hardness of steel alloys and other metals in the range of from 25 to 65 Rockwell C scale. The test set features portability. It can be carried in the pocket on the job. It may be used to test specimens of steel alloy in almost any place or position. It is a direct reading device; no further calculations are required. The tester includes a microball indentor, a measuring microscope and a standard hardness test block.

Pacific Transducer Corp., 11921 W. Pico Blvd., Los Angeles 64, Calif.

Catalogs and Literature

Spectrochemical Analysis—The new issue of Baird Associates "Better Analysis" carries an unusual story of economies effected by instrumental analysis in the control laboratory of one of the country's major steel mills. Actual dollar savings are calculated and intangible returns from quality and uniformity of production are noted.

Baird Associates, Inc., 33 University Rd., Cambridge 38, Mass.

Wood Test Tools—Bulletin 4203 (2 pages) describes and illustrates Baldwin Wood Test Tools that the manufacturer states meet the specifications of ASTM D 143–49 for eight Standard Methods of Testing Small Clear Specimens of Timber.

Baldwin-Lima-Hamilton Corp., Paschall Station P. O., Philadelphia 42, Pa.

Balance—A new 8-page booklet describes the direct-reading, single-pan "Gram-atic Balance," which eliminates all handling of weights, and gives readings in 20 sec. Weights are removed, not added, hence beam load—and sensitivity—is always constant. Booklet also outlines 6-step weighing procedure, lists balance specifications.

Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Low-Temperature Industrial Freezer—Information on industrial freezers as well as complete temperature range testing units developed and manufactured by the Industrial Freezer Division, Webber Appliance Co., Inc., of Indianapolis, is now available in an 8-page folder. Included is information on performance characteristics, sizes, temperature range and applications regarding the industrial freezers and complete range testing units manufactured by the firm. Webber Units perform low temperatures to −165 F and on heat range to +350 F. Twelve models are illustrated with complete information regarding thirty-six standard models.

The Industrial Freezer Division, Webber Appliance Co., Inc., 2740 Madison Ave., Indianapolis 3, Ind.

General Laboratory Apparatus—The Lanco Apparatus News, Volume 4, Num-

(*Continued on page 80*)

(*Continued from page 78*)

ber 2, is now available. In this catalog supplement are listed mechanical convection ovens, constant temperature circulating system, portable pumps, stirrers, thermo-regulators, balances, refractometers, and many other new items for the laboratory.

Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

Accessories for Testing Machines—Detailed information on instrumentation, tools and accessories for Universal Testing Machines is given in Catalog No. 46, just published by the Tinius Olsen Testing Machine Co. Electronic recorders; electronic strain instrumentation; mechanical extensometers; tension compression, wood and plastics testing tools; and control accessories are only a few of the topics covered in this 24-page catalog.

Tinius Olsen Testing Machine Co., 1120 Easton Rd., Willow Grove, Pa.

Laboratory Glassware—Scientific Glass Apparatus Co., Inc., has just announced the publication of two new catalogs. One, known as the "General," has 1000 pages illustrating and describing a complete line of scientific instruments, apparatus and general laboratory glassware and supplies. The second, entitled "Inter-Joint" Glassware, contains 420 pages covering their entire line of manufactured glassware, both standard and special.

Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

Instrument Company News

Applied Research Labs., Calif.—Plans for the establishment of a branch factory at Lausanne, Switzerland, to supply spectrochemical equipment to European manufacturers have been announced by Applied Research Laboratories of Glendale, Calif. Present plans call for a plant of approximately 3000 sq ft. More than 15 technicians will be employed, all of whom will be hired locally with the exception of the general manger. Material for the highly specialized testing equipment will be purchased in Europe wherever possible, ARL officials said, which will enable faster servicing of existing installations and expedite production. ARL's present staff of field engineers will service equipment now in use on the Continent, it was reported.

Beckman Instruments, Inc., South Pasadena, Calif.—This manufacturer of scientific and industrial instruments and precision components comprising a line from pH meters to computers, has started construction on a new 20,000 sq ft building in Mountainside, N. J. To be used as Eastern sales and service offices for the parent company and as an Eastern manufacturing facility for the Beckman subsidiary, Helipot Corp., manufacturer of helical potentiometers, the new plant will be of brick one story high and will incorporate the latest design features for precision manufacturing.

Central Scientific Co., 1700 Irving Park Blvd., Chicago 6, Ill.—Announcement is made Sept. 1, 1952, that the Mallinckrodt line of more than 400 Analytical Reagents will be the principal brand of laboratory chemicals offered to its customers. Warehouse facilities of Cenco's branches are being readied and stocked as rapidly as possible and nationwide distribution of the well-known Mallinckrodt line is expected within the near future.

Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 4, Calif.—Negotiations for the sale of the equipment manufacturing portion of Eastman Kodak Co.'s Distillation Products Industries Division to the Consolidated Engineering Corp. were announced Oct. 21, 1952, in a joint statement by Eastman Kodak at Rochester, N. Y., and Consolidated Engineering at Pasadena, Calif. Thomas J. Hargrave, Chairman of The Board of Directors of Eastman Kodak, and Philip S. Fogg, President of Consolidated Engineering, said that transfer of the business is expected about Jan. 1, 1953. The price was not disclosed. DIP's distillation operations and its business in vitamin concentrates and synthetic chemicals are not involved in the sale.

Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill.—This firm has bought 4½ acres of land adjoining the Southern Pacific Railroad tracks in Los Angeles, Calif. on which to build a plant and offices for the manufacture of Lindberg Heat Treating and Lindberg-Fisher Melting Furnaces.

a NEW good-neighbor

It's a real pleasure to say "hello" and "best wishes" to our big, new neighbor just up the Delaware. In addition to a community pride at having the mammoth Fairless Works nearby, we have a personal pride in this Mill of Tomorrow.

Our technical skills—as reflected in our products—will play an important part in the operation of this big steel mill. For instance, the wide variety of Baldwin testing machines will ensure that the steels produced there will meet the highest standards of quality—just as the Baldwin testing machines, pictured below, are helping today in other United States Steel plants in Chicago, Pittsburgh and elsewhere.

If you are setting up a completely new plant or expanding testing operations in an existing plant, be sure and check with Baldwin. In this complete line, you'll find every machine you need for mechanical testing—SR-4® strain gages and devices, machines to test impact, creep, fatigue, universal machines up to 5,000,000-pounds, many others.

At Baldwin you'll find better testing machines, a wider variety of testing machines, more versatile testing machines. So write today!

EVERYTHING IS BIG AT THE FAIRLESS WORKS:

There are two batteries of 87 modern, by-product coke ovens each; two blast furnaces with combined annual capacity of 1,134,000 tons of pig iron; a combination slabbing and blooming mill. An 80-inch hot-strip mill; a billet mill; a bar mill with a size range from ⅜ to 2-inches; facilities to produce 281,000-tons of ½ to 4-inch pipe annually.

Baldwin-Sonntag Impact Testing Machine being used to study impact properties at low temperatures.

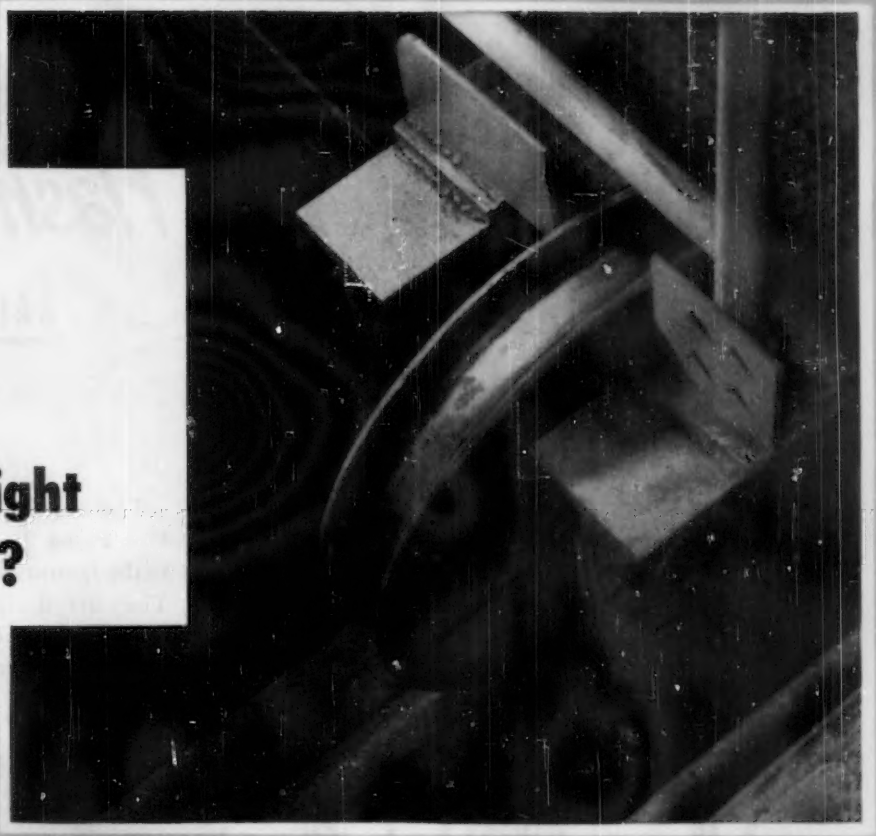
HEADQUARTERS

-LIMA-HAMILTON

Philadelphia 42, Pa. • Offices in Principal Cities

In Canada: Peacock Bros., Ltd., Montreal, Quebec

INDEX TO ADVERTISERS



PRODUCT—
Crane Wheel
MATERIAL—
Steel
EQUIPMENT—
1000 kv x-ray unit

What's the right X-ray film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

Failure of any of this crane's wheels would stymie the smooth production of the plant. So the smart order was "Radiograph them."

To make the radiographs, the radiographer used 1000 kv, 4-min. exposure at 8-feet tube distance, and Kodak Industrial X-ray Film, Type A.

This film has fine graininess with high contrast and sufficient speed to take full advantage of high kilovoltage equipment in radiographing thick or dense materials. It is also first choice for the examination of light alloys with short exposures at low voltages.

A TYPE OF FILM FOR EVERY PROBLEM

To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. These provide the means to check castings and welds efficiently and thus extend the use of both processes.

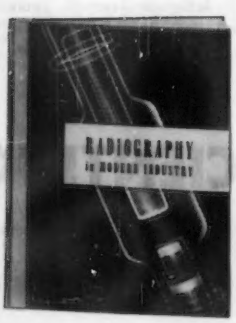
Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography . . . another important function of photography



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

EASTMAN KODAK COMPANY
X-ray Division · Rochester 4, N. Y.

Kodak
TRADE-MARK

ASTM *Flash Point Tests*

NOW EASIER . . . SAFER . . . QUICKER!

The new Fisher-Tag Cleveland Open Cup Flash and Fire Point Testers represent a marked improvement in the famous Tag line of petroleum testing equipment. They are designed and constructed to meet fully the ASTM specifications for determining flash and fire points as given in designation D92.

There are two models, one heated with gas and the other by electricity, and the choice of model and method of heating rests entirely with the personal preference of the analyst. Each of the new models has been designed as a unit to make it easier to move from one laboratory to another. The Gas and Electric heaters are integral parts of the stand assembly.

Simplification in construction and improvement in the operation of these models have provided greater efficiency and *much easier* and *safer* handling by the analyst.

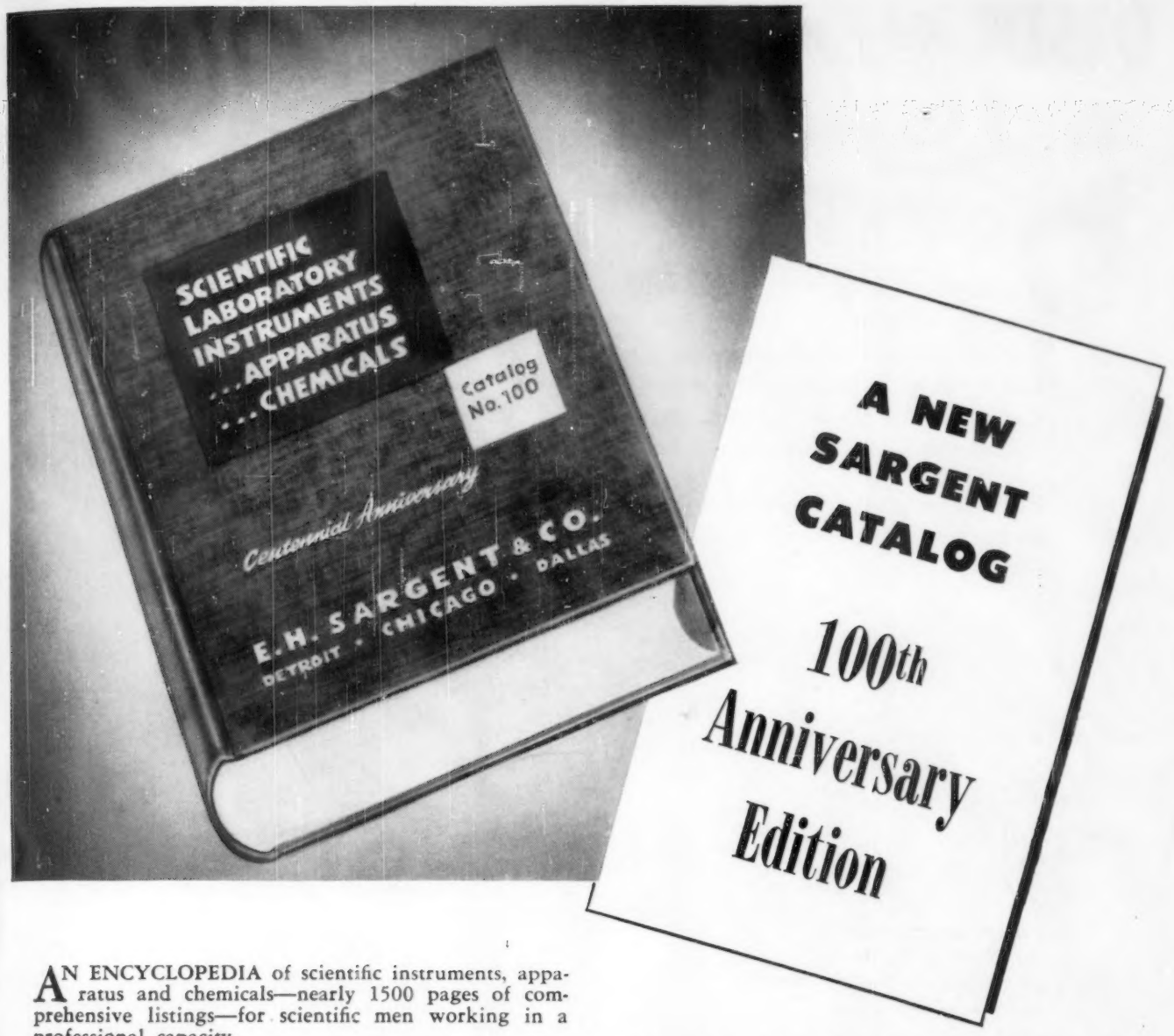
IMMEDIATELY AVAILABLE FROM STOCK

Complete stocks of laboratory instruments, apparatus, reagent chemicals, furniture, and supplies at: 717 Forbes St., Pittsburgh 19, Pa. • 635 Greenwich St., New York 14, N.Y. • 2850 S. Jefferson Ave., St. Louis 18, Mo. • 7722 Woodbury Dr., Silver Spring, Md. • 904 St. James, Montreal, P.Q., Canada • 245 Carlaw Ave., Toronto 8, P.O., Canada.

WRITE for complete information and wide variety of uses of this outstanding petroleum testing equipment.

FISHER SCIENTIFIC

America's Largest Manufacturer-Distributor of Laboratory Appliances and Reagent Chemicals



AN ENCYCLOPEDIA of scientific instruments, apparatus and chemicals—nearly 1500 pages of comprehensive listings—for scientific men working in a professional capacity.

The Sargent Centennial Anniversary Catalog is compiled in familiar alphabetical order by most commonly used names. Subject finding words are located at the outside top of each page for rapid location of items. Cross references are used throughout—making reference to the catalog's elaborate index usually unnecessary.

The Sargent permanent catalog number system is perpetuated—with numbers in sequence with the alphabetical listing and fully identifying each item to insure ease and accuracy in ordering. Completely descriptive titles in bold-face type distinguish alternatives and similarities between listings.

Accurate woodcut illustrations, printed on fine coated papers, assure users maximum detail.

The 100th Anniversary catalog is bound in durable buckram, designed to stand hard use.

Sargent's periodical, "Scientific Apparatus and Methods," supplements the catalog, and contains information about new developments in laboratory instruments and apparatus. Both the magazine and catalog are now being distributed. Please let us hear from you.

E. H. SARGENT & COMPANY, 4647 FOSTER AVE., CHICAGO 30, ILLINOIS
MICHIGAN DIVISION, 1959 EAST JEFFERSON STREET, DETROIT 7, MICH.
SOUTHWESTERN DIVISION, 5915 PEELER STREET, DALLAS 9, TEXAS

SARGENT

SCIENTIFIC LABORATORY INSTRUMENTS
APPARATUS • CHEMICALS

---Attach Coupon to Your Company Letterhead, Please---

E. H. SARGENT & CO.
4647 W. Foster Avenue, Chicago 30, Ill. *Attn.: Catalog Department*

☐ I am ☐ I am not now receiving your periodical, "Scientific Apparatus and Methods"

Name_____

Position or title_____

Department or division_____

Firm or institution_____

Mailing address is_____

Town_____ State_____

Laboratory specializes in the following field or fields_____

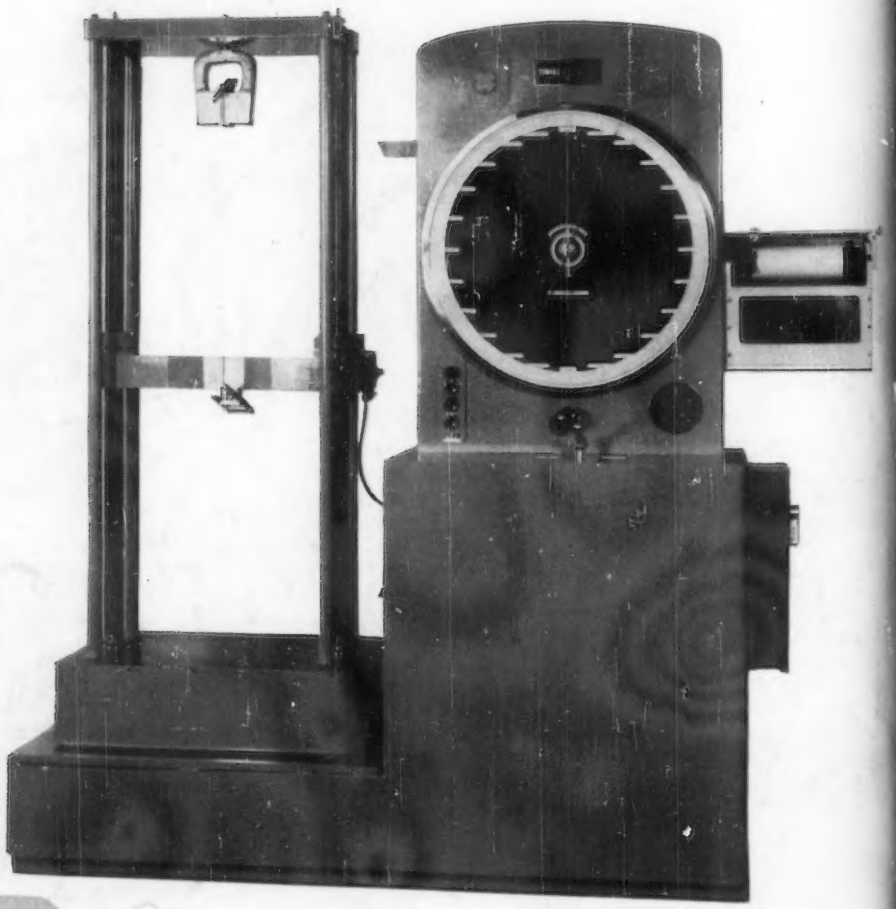
OLSEN *has the answer to your need for a*

TRULY MODERN LOW CAPACITY UNIVERSAL TESTING MACHINE — *at low cost*

The new Olsen Universal Lo Cap is without peer for accuracy, sensitivity, and low cost. Available with modern weighing system of either the pendulum lever type, or exclusive electronic type, utilizing the null system with Olsen SelecTrange Indicator.

Specimens up to 48 inches in length can be handled easily; lower table height provides great convenience for the operator.

The new line of Olsen Lo Cap Universals is available in three capacities: *5,000 lb.* with additional ranges of 1,000 lb., 200 lb., and 50 lb.; *12,000 lb.*, with additional ranges of 6,000 lb., 1,200 lb., and 120 lb.; and *20,000 lb.*, with additional ranges of 5,000 lb., 2,000 lb., and 200 lb.



For low capacity testing, the Olsen Lo Cap line is your answer. We'll gladly give you full details.

Just drop us a line.

TINIUS OLSEN

Testing & Balancing Machines

TINIUS OLSEN
TESTING MACHINE CO.
2020 Easton Rd., Willow Grove, Pa.